PART I

CONCEPT OF RESOURCES

CHAPTER 1

INTRODUCTION

Geography of Resources, a major sub-division of the field of Geography, concerned with utility of natural gifts in area differentiation of economic landscape. All the existing landscape reflects the complex resource structure, economic processes and the stage of economic development. Geography of resources is the study of the characteristics which distinguish one area from another, with interest focused on utility of natural resources rather than specific objects or processes as such. It is the study of differences between economic regions in terms of their resource development and their economic characteristics. The concept of geography of resources arising out of areal economic differentiation. The geography of resources is a broad field related to all branches of geography. Indeed, the field of Geography of resources is so broad that it cannot be included wholly within geography ; resources are also studied by natural scientists, economists and others—though from different point of view. Primarily. geography have studied such natural resources as soil, water, forests, minerals etc In addition they have mapped and interpreted the distribution of these resources, clarified their interrelated nature, defined unified natural regions such as river basins and helped to plan appropriate programs of resources base has made possible realistic development programs in developing countries of the world. Similarly, the astronomic growth of resource use in developed areas requires the continuing study of resources in terms of their distribution and future use.

Many years ago economists came to be defined as the study of scarce resources with alternative uses that aggravated the insufficiency, water a priceless resource—would have been the last thing chosen as an example. Indeed, as a renewable resources, it might even have lent itself to illustrate how unsatisfactory the definition was. The world has travelled a long way since. Between a plundered plant and an improvidently growing population the best things of life are becoming scarce and expensive. We are adding 75 million to the population of our world every year, and natural ecosystems are understandably breaking down under this strain.

The U.N. Environmental Conference at Stockholm brought together a large number of scientists and thinkers who were deeply concerned about the ecological degradation of the world and related problems. Experts and politicians gathered earlier for environmental crisis in effect warned all governments that between reckless wastage and thoughtless pollution mankind was moving inexorably towards ecological and economic disaster.

Modern scientific man ruthlessly destroyed the ecosystem in the name of industrial civilization and human progress. Modern industrial civilization is being built more and more upon inorganic resources[1]. As industrialization continues and spreads to more regions of the world, the consumption of minerals can be expected to increase enormously, although the quantities of raw materials required to produce a given quantity of certain consumers goods may be substantially reduced by technological changes and by the development of synthetic materials. As industrialization progresses, the composition of consumption changes in such a way as to increase the relative importance of other scarce items, such as mineral products ; these may become the determinants of the maximum population.

The estimates of resource. ownership patterns connot be satisfactorily based on amounts of available resources even assuming the possibility of a reasonably accurate inventory, for they must also take into account of shrinking quantities of resources and their expanding utility. Zimmermann has introduced the concept of the "phantom pile", which can be applied to all available and useable resources. Any advances in science and technology, for example, that increase production which increase the "pile" but actually reduce the amount of "pile". Zimmermann's "phanton pile" is also applied on land—a basic resource Any advance in agricultural and other technology, for example, that incerase yields on land of a given quality act to increase the "pile". On the other hand, practices inimical to the quality of the land, such as those allowing erosion and decrease of fertility, essentially reduce the 'pile'. How much land there is to how many men is a fundamental consideration in the life of any society, not in a simple quantitative sense, but in the man-land ratio, a qualitative concept of sociologists that takes into account all the human qualities bearing on productivity and all the environmental aspects, both natural and cultural, affecting the availability of resources.

The Divisions of Geography of Resources

Geography of resources has developed in an attempt to illuminate the many and diverse problems of economic man. As a result, it is a cluster of several specializations within geography rather than a single clearly defined field. Its classic divisions are land as a resource, natural resources—soil resource, biotic resources, mineral resources, energy or power resources and human resources.

Natural resources comprise the land, mineral deposits, climate and all other materials and condition's that are originally furnished by nature. The natural resources may be subdivided almost without limit in terms of use relationship of minerals, power resources or other ubiquarian characteristics. Climate determines the location

1 Inorganic resources such are water, the mineral fuels, the metalliferous ores, building stones, and the valuable chemical raw materials of the earth or air. Organic resources are such as are derived from the natural plant and animal life of the various parts of the earth.

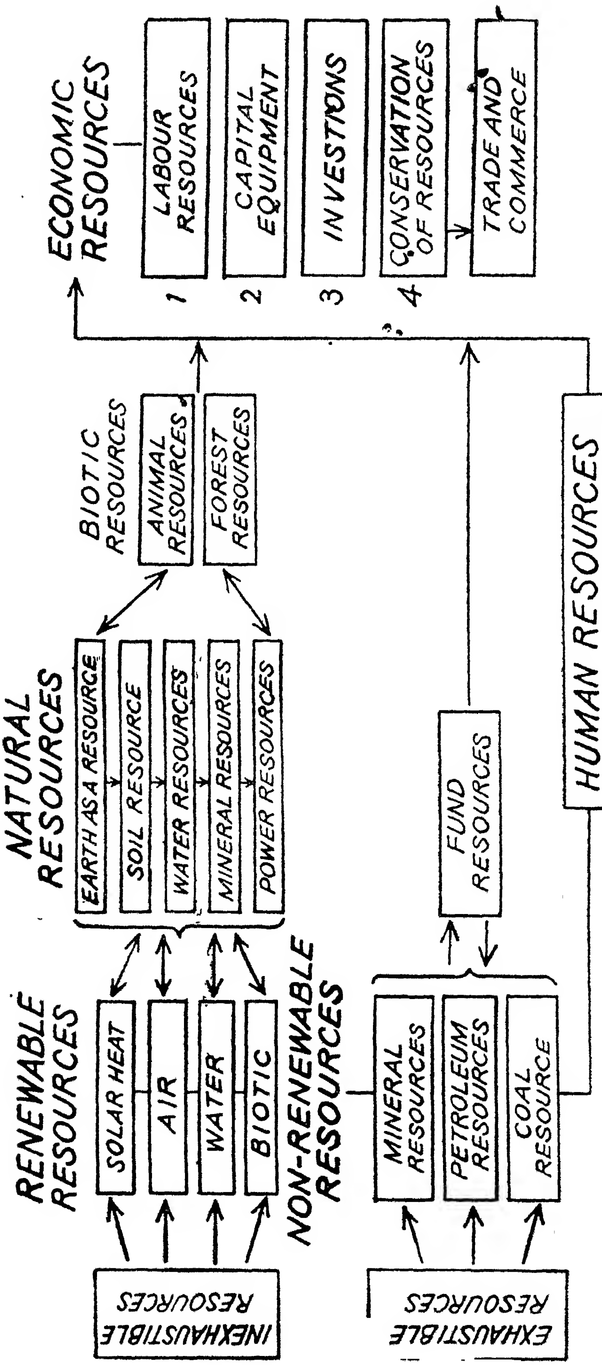

Fig. 1·1. Some components of Geography of Resources

and distribution of agricultural resources. Cost factors, in turn, are influenced by the relative scarcity or abundance of the resources.

Thus western Uttar Pradesh endowed with large amounts of fertile soil and relatively little human power and equipment is likely emphasize extensive production of agricultural porducts; whereas Hooghly region of western Bengal endowed with large aggregates of equipment and skilled labour is likely to emphasize production of more complex manufactured products. The economic utilization of natural resources, of course, is accomplished only by human action. However, only land as a resource and the geography of mineral production are highly developed today and their utilization reached at saturation point. Economic geography and geography of agricultural resources are not strictly considered as divisions within geography of resources, since their fields of interest are so broad as to overlap into many subjects. Some components of geography of resources is illustrated in fig. 1·1, which attempts to provide a simplified summary of some of the themes that are of importance in geography of resources.

This figure shows that each of these broad categories of resources may be further subdivided. The components of each are not entirely homogenous, and therefore, are not entirely in competition with or substitutable for one another. Subdivisions run along the lines of these partially non-competing groups. Thus the economic resources may be divided into three broad groups : labour (human resources), capital equipment (produced resources) and nature (natural resources).

The amount of labour available for the production of economic goods in a society is determined by a variety of demographic, economic and social factors, the most important of which are those associated with the size and structure of the human resource. Long-term trends in fertility, mortality and migratory movements determine the size of the human resource and its composition with respect to sex and age, and establish the maximum limits of the number of persons who can participate in economic activity. Other demographic factors, such as the urban rural or urban composition of the human resource and proportions of women who are married and have responsibility for the care of children also play an important part in determining the proportions of the human resource which will be represented in certain age groups in the labour force. A large variety of economic and social factors, among them the type and organization of production, level of income, and the relative values placed on competing economic and non-economic roles, are also believed to be influential in deciding how many of the total number of persons at a given age contribute to the labour supply.

The labouring resources may be classified into skilled, semi-skilled and unskilled groups. Each of these subgroups, in turn, may be subdivided on many other factors that reduce the occupational or geographic mobility of labourers. Thus various economic regions

may vary considerably among themselves in the types of products their equipment enables them to produce. There is a general tendency for an economic region to specilize in the making of those goods in which its most abundant or least costly resources are an important element. The most highly industrialized nations have been those which contained adequate supplies of coal, iron and educated and efficient workers. In large measure, those regions that are relatively undeveloped industrially are so because of a deficiency in some or all of the requisite resources.

Resource is Dynamic or Static Concept ?

Resource exploitation and conservation is dynamic concept which are usually associated with changing uses of natural resources, causing scarcity at one time and giving the appearance of abundance at other times. The prevailing attitude towards scientific development and individual freedom respectively is generally reflected is national polices affecting resource exploitation. The concept of resources are not a static or stand still but dynamic element experiencing continuous change and constant evolution. The laws governing the use of water resources illustrate with particular clarity the relationship of relative scarcity or abundance of resources to the development of society and industries. The water of Damodar valley, only for example, was crushed before planning, but now it is bone of industrial development of the whole India. "In the United States the legal theory that subsoil minerals belong to the owner of the surface land resulted in unrestrained exploitation, which led in some instances to truly chaotic conditions." In general a more or less unrestricted exploitation of natural resources prevails during the various stages of industrial development, when the value of resources is more clearly appreciated and the dangers of exhaustion become manifest, the tendency is for the state to regulate the rate of exploitat on and demands for conservation and socialization arise. Intelligent conservation requires careful analysis of individual resources, areal interrelations and past, present and future resource needs. The degree of technological development is an important factor in the solution of the problem of the optimum allocation and use of resources. First, invention and discovery may change the very nature of a region's resource endowment. Materials once thought to be useless may come to be the basis of entire new industries. This is Negation to Negation approach of resource utility. "The native African iron worker, for example, draws on limited but high quality supplies of bog iron, shells, and charcoal for the raw materials for his smelter. But the large steel mill owner of the United Kingdom must look to overseas supplies of high-grade hematite, or local supplies of beneficiated taconite. He must have acccss to large deposits of good quality coking coal, and limestone obtained, preferably, from the local area. Both the African smelter and the steel mill owner use resources, but these are not interchangeable and must be strictly related, the one to a handicraft

activity, the other to a major industrial enterprise. Quantity and quality are factors to be considered in the location and use of these resources."[1]

Secondly, a number of factors contribute to the becoming of resources. Among the most important, is the dependence of resource values on the stage of technological development of the society using the resources. Technological development, along with the imporvement of management techniques, constantly alters the character of the optimum combination of resources. Mechanization has changed the amount of land that can be effectively cultivated by one man, and has greatly lessened the use, per unit of output, of oxen and horses. The introduction of new machines has in many instances changed the character of the labour performed by the human resource.

The geographical distribution of resources is one of the principal determinants of the character and location of industry, the economic and political power of nations and the plane of living of the population.

1. Craig Duncan, Resource utilization and the conservation concept. Economic Geog. vol. 38, p. 115, 1962.

CHAPTER 2

CONCEPT OF RESOURCES

Resources means literally the description of all the accessible and available wealth of the universe. Resources are those aspects of man's environment which facilitate the satisfaction of human wants and the attainment of social objectives.

Wherever man lives he has to adapt himself to his surroundings in order to get the two fundamental necessities of food and shelter. The need for clothing, which is a form of shelter, is decided by the climate. In the following table the effects of climate is shown graphically on human activities :

Climatic controls		**Climatic Elements**		
1. Solar heat 2. Land and water 3. Winds and air masses 4. Altitude 5. Mountain barriers 6. Ocean currents 7. Storms, etc.	Acting upon →	1. Temperature 2. Precipitation and humility 3. Winds and air pressure	Produce →	Politico-Socio-Economic activities of man.

Man is a creation of his environment. Resources are features of the environment which are or are considered to be, capable of serving man's need; they are given utility by the capabilities and wants of men. A group of people can only prosper, increase and grow powerful, when their environment supplies them abundance of food and other necessary things of life. The highest order economy possessed and standard of living enjoyed by the people of U.S.A. among all the nations of the world has resulted from the composite of three paramount factors (i) abundance and variety of natural resources, (ii) leadership in development and application of science and technology, and (iii) comparatively small population.

Every man, whether he may be rich or poor, civilized or uncivilized, resident of cold climate, or living in warm latitudes, requires food, clothes, house, fuel, luxuries, tools and materials of industry which enable him to produce and handle the others.

All the above mentioned things are produced directly or indirectly from Nature. The forces of nature go on doing their work irrespective of what use man may or may not make of them. These inexorable laws of nature keep the whole physical environment in perpetual change. The atmosphere is constantly changing from one stage to the other and thus affects human activity to a greater extent.

The forces of nature make our weather and climate which have such a far-reaching-influence on our life. They make our landscapes which determine our habitat and control our movement. Climate is clsoely related in determining the type of biotic resources, agricultural activity and human resources. Nature determines to a very great extent the occupation of the people, their dress, their mode of living and their habits. Societies have always begun to seek ways of satisfying their needs in the immediate vicinity[1].

Efforts on the part of man to make adjustments to his natural setting are universal and involve some of the major and important problems in which the drama of human life and activity is constantly being enacted. Thus resource geography is the study of functional relationship between man and his environmental gifts. Resources are not, they become so, because of man's cooperation as stated by Zimmermann.

Man is never completely passive, or rather he is entirely passive only when the agents of the physical world deprive him of life. So long as he is alive he acts and reacts, he eats and drinks and lies down on some spot on the earth to sleep, and in all these acts it is easy to recognize the signs of his own participation in natural gifts.

Resource geography deals with conditions on the earth, the distribution of people as a biotic factors on the surface of the earth and finally the relationship of man to the various resources. From the standpoint of resource geography, man is the dominant factor.

The relationship between man and resources are ever changing, it is essentially dynamic and never static. Resources and resistances exist side by side. As a result the extent of human satisfaction is a function of resources and resistances and not of resources alone[2].

Man is actively engaged in changing the face of the earth, often in an appallingly destructive manner. According to Marsh "man disrupts the fundamental harmony or balance of nature"[3]. Civilized man spreading everywhere and turning all the available and accessible natural resources of the earth or parts of the earth's surface to his uses, has succeeded to some extent in reducing its physical differences. The earth is modified by human action is a conspicuous fact of historical development. Reclamation of marshlands and submerged areas in the Netherlands is cited as the greatest geographical transformation that man has brought about on the earth's surface. Man's connection with the cultural earth, is at the same time active and passive. He is both the most dynamic agent of production and the beneficiary of the entire process of resource development and utilization. Man speaks of his conquest of Nature and imagines himself entirely a free agent. His conquest

1. Blache, Vidal de La, Human Geog., p. 320
2. Zimmermann, E.W., World Resources and Industries, 1951.
3. Quoted by Arthur A. Ekirch, Man and Nature in America, 1963

of Nature means that he has found in some measure how to utilize the natural resources for his satisfaction of wants. According to Zimmermann resources is a means of attainment of given ends. The ends begains satisfaction of individual wants and attainment of social objective[1].

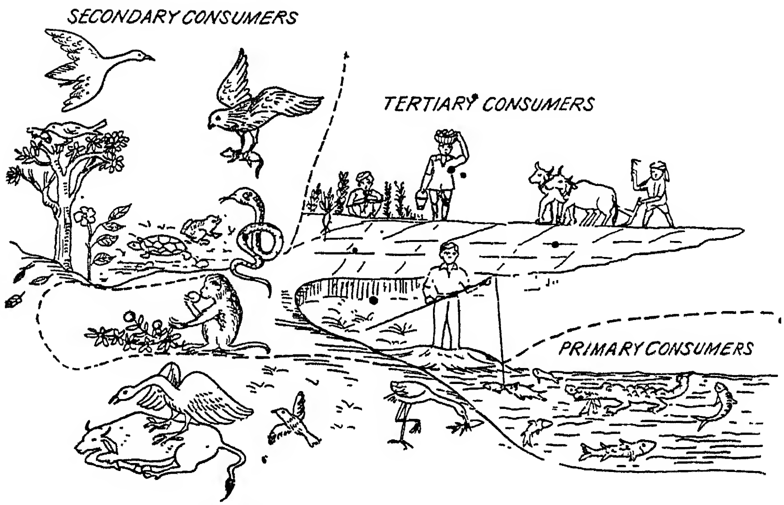

Fig 2·1. Interlinked chain of biotic communities

Resource utilization and ecological crisis

The gifts of Nature and human development can not be separated in this study. Thus resource geography has to study not only the distribution of natural resources on the earth's surface but also how this distribution has been utilized by man for his material progress. Ecology tells us that the biosphere is unitary, that the natural life-support systems of the species on earth are highly interlinked. Fig. 2·1 shows the interlinked chain of biotic communities. The preservation of the delicately balanced ecological system is in the interest of the whole mankind. In the words of Radha Kamal Mukerjee, "the human group must be considered in a stable equilibrium not merely with reference to temperature. huminity, sunshine, altitude etc., but also to their indirect effects, the interwoven chain of biotic communities to which it is inextricably linked, the plants it cultivates, the animals it breeds and even the insects which are indigenous to the region.

Environmental scientists the world over are profoundly concerned over man's abuse of nature in the name of human progress. Under the influence of the stimuli provided by Nature, or as a result of the efforts man makes for satisfying his wants, the material progress is created. Land is cultivated, irrigation is provided, industries develop, rivers are bridged, roads and railways

1. Ibid.

are built, towns grow and there is the whole paraphernalia, of modern civilization that is born simply out of man's efforts for

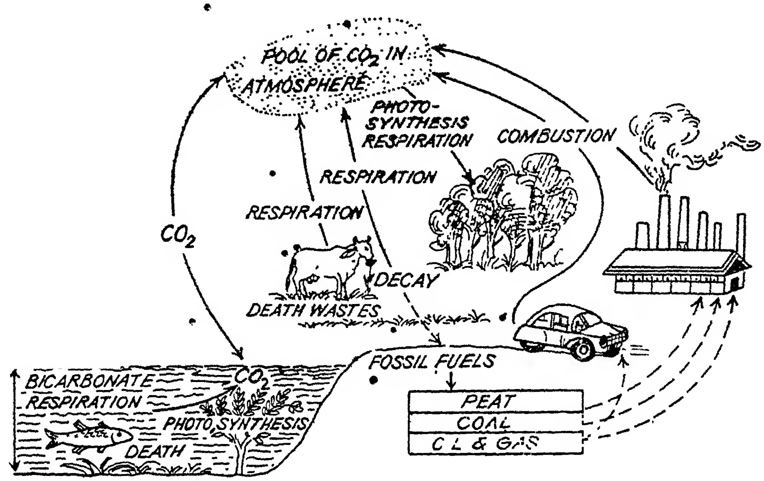

Fig. 2·2. Carbon cycle

satisfying his wants. He ruthlessly destroyed the natural resources of the world. Environmental scientists warn that if the present

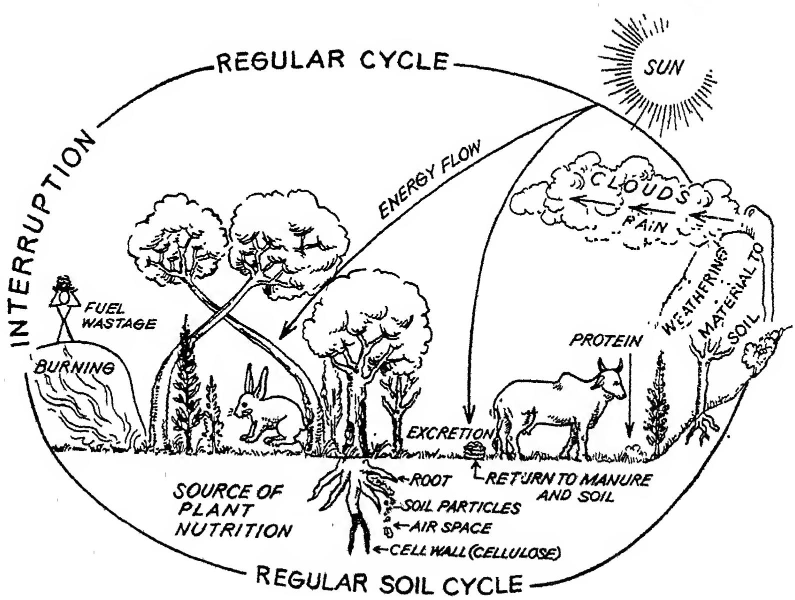

Fig. 2·3. Soil Cycle

rate of air, soil and water pollution persisted the biological rhythm on the earth would be irreversibly upset and man himself might face a long-drawn-out process of extinction. The industrial and agricultural progress which bring a higher standard of living also have undesirable effects on the physical environment of man.

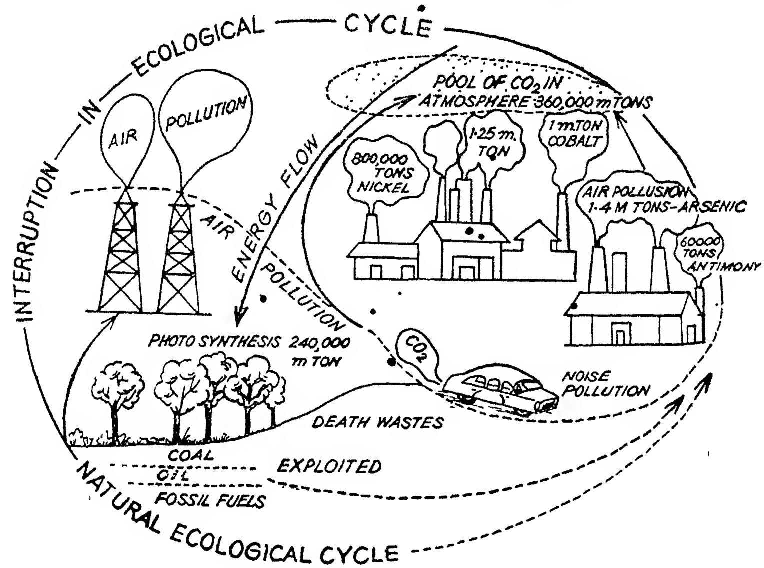

Fig. 2·4. Air Pollution

We live in an environment which is created by biological activities. The oxygen we breath is produced by green plants by using carbon dioxide, for example, and so that the environment is a self-cleaning system. There are also systems in the soil which enable it to absorb human waste and convert it into humus which is then able to support the growth of plants which in turn feed people. As shown in Fig. 2·2, the process of photosynthesis forms the primary pathway by which carbon is withdraw from carbon dioxide "pool" and is used by plants to build carbohydrates and other organic compounds. These compounds transfer the carbon to herbivores which eat the plants. When herbivores are eaten by carnivores, the carbon moves farther along the food-chain. Both plants and animals extract energy from these organic compounds by the complex biochemical process called cellular respiration. So there is a cycle of ecological processes. In the more advanced countries the cycle is broken by dumping the human waste into water where it integrates with the water cycle, even after treatment. More important, it is not returned to the soil cycle. Fig 2·3 shows the regular and interrupted soil cycle. The dotted lines show the interruption of regular cycle. This breaks the ecological integrity of both the soil cycle and the water cycle. This is an example of the way in which we are beginning to break down the self-contained, self regulated properties of the environment.

Industry is belching more than 800 million tonnes of pollutants, like soot, noxious fumes, gases and chemical substances, per year into the air, and letting out millions of tonnes of chemical effluents into rivers, lakes and the seas. Over the last seventy years it is estimated 1·25 million tonnes of flint, 1·4 million tonnes of arsenic, 600,000 tonnes of antimony. one million tonnes of cobalt and about 800,000 tonnes of nickel—all extremely poisonous substances—have got into the atmosphere. Fig. 2 4 shows the imbalanced ecological cycle created by man

Through the burning of fossil fuel during the last one hundred years, more than 240,000 million tonnes of oxygen was exhausted and about 360,000 million tonnes of carbon dioxide was discharged into the atmosphere. This has led to a higher carbon dioxide content and oxygen deficiency of the air. Fig. 2·5 shows the causes of higher carbon dioxide and oxygen deficiency near the Earth's surface.

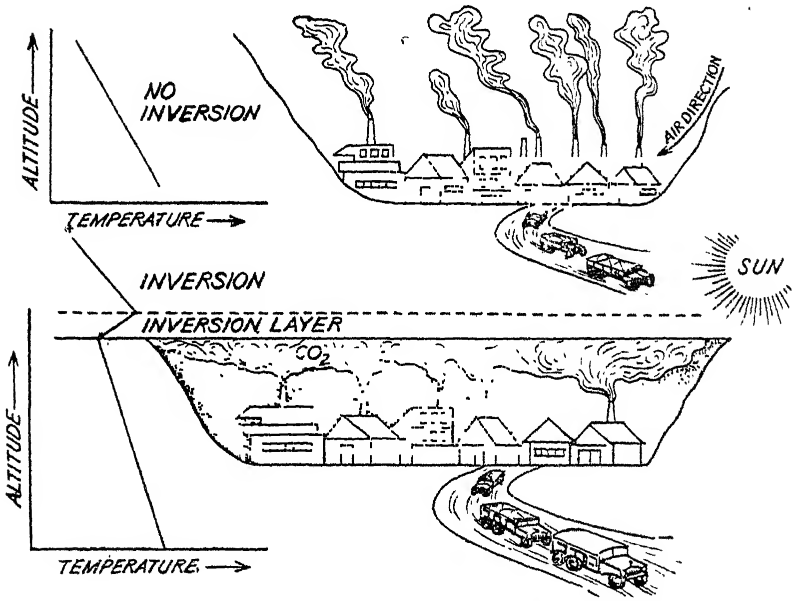

Fig. 2 5. Oxygen deficiency near the Earth's surface

The basic reason for the ecological crisis is man's indifference to nature and his adaptibility to the deteriorating environment. Today, the exploding populations and the technological pressure to sustain them spells new dangers to the biosphere. The projection of six to eight billion people on earth by the year 2000 (twice as many as now) are sure to bring about a global catastrophe. It took the world a million years to reach the first billion mark in population. The second billion was added in another 100 years and the third in just 60 years. At the current rate of growth, the world population of 3·5 billion will double within the next thirty

years. Such a population upsurge could strain the earth's dwindling resources and endanger the stability of ecosystems that provide food, oxygen, and water, besides creating uncontrollable socio-economic problems. The ecosystem concept emphasizes the functional relationship among organisms and between organisms and their physical environments. These functional relationships are exemplified by the food chains through which energy flows in ecosystems. Thus almost every region has exhibited significant changes in the number and content of its plants, lower animals and human population.

Resource Questions :

The various questions of resources which may be raised can be explained here :

1. Unlimited wants and Resources

Man is a boundle of wants.. A man's effort will always be directed toward acquiring more and more resources that can be converted into means of want satisfaction. Human desires, or ends, being practically without limit, resources are always relatively scare, hence the bringing into relationship of these scare resources with desires leads to a form of behaviour we call economic activity, and which consists in choosing between alternatives ; for if our resources are only sufficient for the attainment of one desired end, certain others must be relinquished.

In all times and places, and in all sets of circumstances, this fundamental problem is ever present. Because resources are scarce, relative to the ends which they serve to accomplish, we must choose incessantly between alternative goods, or between alternative uses of the same service or good, and our choice is determined, partly by the end in view, and partly by our estimate of the value of the loss of some alternative end that otherwise would be realised. Resources used for one purpose are not available for an other, and the scarcer the resources are, the more vital the importance of this simple fact.

If the scarcity of resources relative to ends is the first fundamental principle of geography of resources, this distribution of resources, or choice of ends, is the second. It is independent of time and place, and any particular stage of civilization. The savage did by instinct, developed by experience, what we do by conscious deliberation. In the economic civilization in which we live, this principle governs the administration of the resources of every national household ; of the industrial world as well as the distribution of the public resources of the state ; as Malthus[1] has so admirably shown.

2. Growth of World Population and Resources

Estimates of world population at the beginnings of human history are understandably hazy, but estimates for as early as 7000 B.C. are from 5 to 20 million. At the beginning of the Christian era, this figure had increased to anywhere from 100 to 300 million.

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1. Malthus, Robert—A summary view of the Principle of population, 1804.

Fifteen hundred years later, in the time of Columbus, approximately 500 million people are believed to have inhabited the planet. In 1700, the figure had reached 700 million. In 1971, about 3706 million lived on our earth. It is estimated that by the year 2000—only 24 years from now–the present number of 3706 million people will have doubled to 6424 million at the present rate of growth. Table 1·1 summarizes the population history of the earth.

Table 1·1

Doubling Times of Population

Date	Estimated World Population	Time for Population to Double
8000 B.C.	5 million	1500 years
1650 A.D.	500 million	200 years
1850 A.D.	1,000 million (1billion)	80 years
1930 A.D.	2,000 million (2 billion)	45 years
1975 A.D.	4,000 million (4 billion)	35 years
	Computed doubling time around 1976	

The growth of population for the past one-half million years is shown in fig. 2·6. The sort of graph shown in fig. 2·6 does not reveal details of trends in the long, slow growth of the human population before the current millennium.

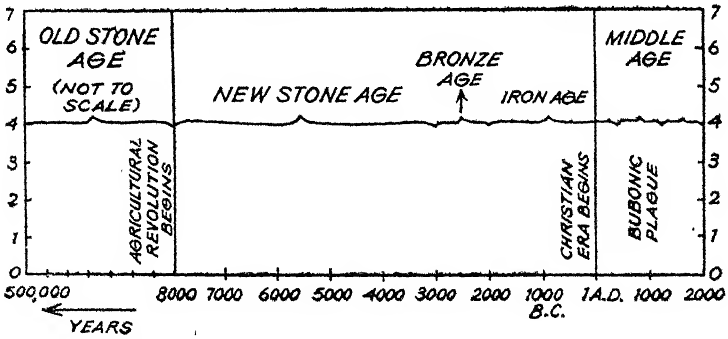

Fig 2 6. Growth of Population for the past one half million years. If old stone age were in scale its baseline would extend about 5·4 metres to the left After population Bull. vol. 18 No. I. Kg1.6.

In the words of Malthus : "A perfectly happy and virtuous community...will double every twenty-five years, but there can be no similar increase in their food, the best lands are taken up first, then the next best, then the inferior, at last the worst ; at each of stage the amount of food produced is less than before," His

speculation's centered on the proposition that man's "power of population is indefinitely greater than the power in the earth to produce subsistence," which he propounded with strict immutability and mathematical regularity characteristic of the Natural Laws of the Age of Reason as "population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio"[1] Thus according to Malthus, population of the earth would increase in a geometrical progression, and food in an arithmetical progression. If the original population and produce are each denoted by 1, the population in successive periods (*e.g.* of 25 years, this being about the time in which a quickly growing population will double its numbers) will be given by—

1, 2, 4, 8, 16, 32, 64 (after 150 years)...........

If Malthus statement is rigidly true, the produce in successive similar periods will be—1, 2, 3, 4, 5; 6, 7 (after 150 years)......

Again by the aid of historical research, Malthus showed that no populous country had ever been able to obtain necessaries so easily and so abundantly as in a thinly populated region, and that the greater the population, the greater was the difficulty in producing food, greater consumption and use of natural resources. Most past and present wars are economic in origin, in part at any rate. War is not a public consent but only one man decision. This is seen in the case of nomadic raids : time after time the Central Asian population has grown beyond its food resources, or conversely, a change in climate has lessened the food supply ; in each case, the fertile lands have been raided. If the statement is exact, it is plain fact that an increased population will very soon be faced with starvation, and Malthus believed that the difficulty of producing the extra food would be even greater than the arithmatical statement supposes.

One of the most acute problems facing a large section of the world's population is limited available resources and shortage of food. These people must be fed and the way to ensure this is to raise their incomes, since a basic cause of hunger is poverty. The solution of this problem is agricultural development, which is the corner-stone of social and economic prestige of society. In developing countries about 60 to 80 percent of the total population is engaged in agricultural sector of economy. The most important means of eking out livelihood to the people is agriculture, because the other natural resources, have not yet been exploited fully and properly. The population of these developing countries are distributed between workers and non-workers in the ratio of 78 and 22. Among worker 70% works as cultivators and agricultural labours. Next comes house hold industry and other manufacturing jointly claiming for 20 percent followed by other services about 10%. The largest number of workers is in the age group 25 to 40 amounting for 50 percent followed by next age group 40 to 50 accounting for

1. Malthus, R., op. ci .

50 percent. While lowest above 50 and below 75 years of age. If we visualise this problem deeply we will see that there are some other related problems such as poverty, illiteracy, ill health, disease and hunger and population explosion.

We now know with a little more certainly the extent of hunger in the world—that one-third to one half of mankind, that is 1000 million to 1606 million people, still suffer from hunger and malnutrition. Further more, the hard core of these, some 300 million to 500 million people, are hungry even in normal times. But on the other side the rich countries are getting richer and poor countries are getting poorer, and unless drastic action is taken by International Agencies or various governments, the chances of the incomes of the poorer countries rising are very small, partly because the prices paid for primary agricultural commodities on the world market are increasing. Another disturbing possibility is that, in the next decade, food surpluses may continue to accumulate in form of buffer stocks in some countries while, in others, people will still be hungry.

The world is getting more and more crowded with a total population of over 3706 million an increase of almost one-sixth since 1950. Population census taken during 1962 and 1971 showed an average growth rate of 1·8 percent a year in the world's population. There are now twenty-two persons for every square kilometres of land, compared with eighteen only ten years ago. The faster growing region of the world was central America, where the average annual rate of growth was 3 percent, but south-western Asia comes close behind with an annual increase of 2·6 percent.

The slowest growth is in Northern and western Europe, where the population is increasing by only 0·7 percent a year. The most densely populated region of the world is still central Europe, with 137 persons per square kilometre. The Netherlands is the most tighty packed single country, with 342 people/km^2, followed by England and Wales 303 people/km^2, Belgium 300 people/km^2 and Japan 252.

But certain islands and city states are even more crowded. Population densities of between 2800 and 15,000 are found in Gibralter, Hongkong, Singapore, Monaco and Holy See, while Malta has 1040 persons/km^2, Bermuda 805, Barbadoes 564 and the channel island 561. The population explosion is being aided by the fact that birth rate now double than death rate, with continuing advances in health and nutrition. In 1971, the estimated world birth rate was 34 per 1000 population, and the estimated death rate exactly half this fiigure. The highest regional birth rate (48 per 1000) and the highest death rate (49 per 1000) were found in Tropical and western Africa.

On a map 2·7 of the world, shade in black which includes Asia, Africa, South and Central America, and leave the rest clear–Europe, North America and Oceania. The shaded part contains 2100,000,000 people—two-thirds of the world's population. The

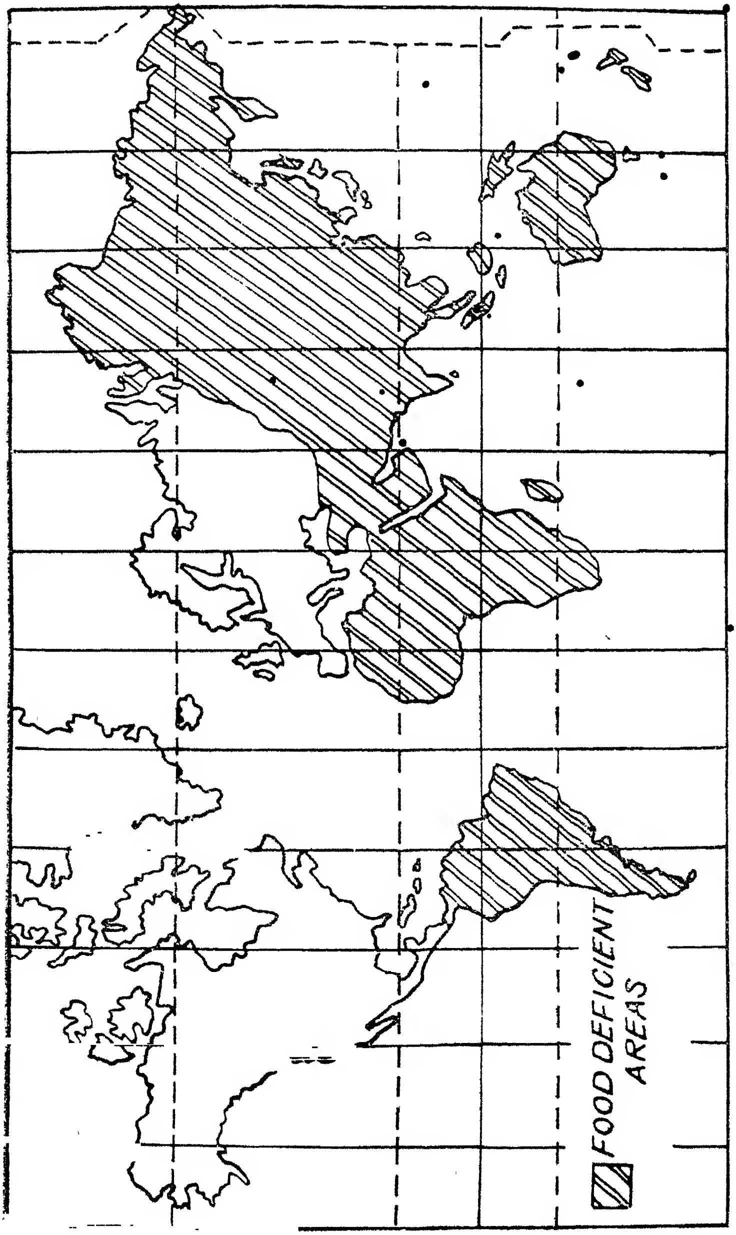

Fig. 2·7. Food Deficit Areas

light area has 1606,000,000. The lighter part is where the more privileged people live. They only represent one-third of the world's population ; but they eat nearly three-quarters of all the food produced on earth.

The 2100,000,000 people in the shaded area have to make do with the other quarter. In fact, Asia with help the world's population, gets only one-sixth of food. Inequality does not end there. In the shaded area, thousands of people die of hunger each year. Hunger has existed all through history. It disappeared from Europe only a century ago, but in Asia and Africa hundreds of millions of people are still threatened by it. Despite all the progress made by science and technology, in our atomic age, hundreds of millions of men, women and children are dying, suddenly or slowly, of famine and malnutrition. Two out of every three men alive today are hungry.

3. Scarce Resources

In the industrially advanced countries we notice the concern for a cleaner environment has almost reached the point of "geolatry." The ruthless exploitation of the resources of the earth by the developed countries is made worse by a capricious commercial sense. Millions of tons of agricultural products have been regularly stored or destroyed to keep prices up in the world markets. By 1960 the so called farm surpluses were estimated at 125 million tons of wheat, an amount sufficient to provide food for every inhabitant in India for a year.

According to recent United Nations figures, the U.S. produced an annual average of 37.5 percent of the world's total production of energy between 1955 and 1968, while consuming a little over 39·8 percent. The balance was imported. Japan produced 2·1 percent of the world's total and consumed over 3·3 percent. The west European countries all consumed more than they produced. Of the industrially advanced countries the Soviet Union is the only exporter of energy producing more than what it consumes. At this rate, it is estimated, the fossils deposits of the earth would not last longer than 2200 A.D. The world demands on other mineral resources of the earth are equally alarming. To raise the living standards of every body at average American levels, the annual production of iron would have to increase 75 times, that of copper 100 times, that of lead 200 times and that of tin 250 times. If India were to use fertilizers at the per capita level of the Netherlands, it would consume one-half of the world's total output of fertilizers. The limited resources of the earth just do not permit such a transformation.

The capacity of man on the scarce resources of the earth seems to be more characteristic of the people living in the industrially advanced countries than those living in the developing nations. The highly industrialised countries, which contain only a small portion of the world's population, consume a disproportionate share (on a per-capita basis) of the world's supply of energy-producing fuels and

mineral resources. About six percent of the world's population consumes nearly 40 percent of the world's processed resources year by year. The imbalances are equally pronounced in the raw materials sphere : 30 percent of the global population lives in industrialised areas and consumes about 90 percent of the total world production of energy and mineral resources.

4. Civilization

The influence of physical environment on human activities in the historic past is very well-known. The story of human progress, both in space and time, is a process of man's adaptation to his geographical milieu. With the event of scientific era man has become prosperous due to technical knowledge and by utilization of resources. He has also created his cultural activities side by side The distribution of population on the earth's surface is merely a manifestation of man's cultural activities, where there are plentiful natural resources, the population density is great. Since man's occupance of the earth, he seems to have selected only those places where he could find numerable resources for his livelihood. The development of civilization depends upon an increasing exploitation of natural resources and the development of closer interactions between a land and its people.

Man has always been interested in the earth on which he lives. It should be remembered that the utility of natural resources has been modified by the cultural activities, because people may react differently on the earth's resources. Thus resource geography studies man's adjustments to the resources and the peculiar ways in which he conforms or adapts his life either wholly or in part to physical and organic Nature. Man was held to be part of nature, and natural sciences focus its attention primarily on the study of inter-relations of man and his geographical gifts. Geographical gifts influence the economic and social development of a people by the abundance, paucity or general character of the natural resources.

5. The Role of Scientific progress

The economic exploitation of the natural resources for the well-being of mankind is consequent upon scientific inventions or discoveries. If we visualise the past history, we shall find that there have always been differences in population and in the social, political and economic institutions. It is also seen that none of the various regions has been synonymously developed as far as natural resources are concerned. These regions gain their final and last importance because of the people who occupy them, physical features their local conditions of soil, climate, natural resources and geographical location are important factors in the origin and development of particular region.

Man in his large activities, as opposed to his mere physiological or psychological processes, can not be studied apart from the earth as a home of Man. Since early time, man has altered his natural wealth in large scale. He has, however, altered very drastically his

scientific know-how, his social and political organization, and his economic methods of utilizing the natural resources or natural gifts. Consequently, his scientific and technological progress for making adjustments with natural resources has been enlarged and changed almost beyond belief. Human society always makes social and cultural adjustments to their natural resources for their proper utilization and exploitation. Thus, the cultural development of man with natural resources form the subject matter of geography of resources.

6. Development of Material Culture :

All human beings live in an environment in which resources of every kind are strictly limited in relation to the ends or wants to whose realisation they contribute. It is often argued that the enormous multiplication of resources resulting from the application of scientific principles to production has solved the age-old problem of scarcity, but this is true only in a limited sense.

It is true today that, thanks to the revolutions in mechanical transport, the fear of famine has been removed to some extent, and also that many commodities which were the luxuries of the affluent classes of society a few generations ago are necessities now in every working-class household.

On a broad view, however, the fundamental problem still remains because, if resources have multiplited, so have ends or wants at an even greater rate, and it is only in relation to wants that resources have meaning It must also be remembered that resources can only be used in time, and although even time can be economised by mechanical inventions, which is the same thing as saying that it can be made less scarce, yet in relation to the accomplishment of aims, it tends to become relatively scarcer, as with every advance in material culture, wants multiply so rapidly.

THE FUTURE DEMAND OF NATURAL RESOURGES

It is generally believe that in the future it will be impossible to satisfy the demands of the world population from natural resources alone. The question arises whether there apprehensions are justified and if so, to what extent. To answer this question it is necessary to consider the estimated growth in the population and the known possibilities of providing it with accommodation, food and water, as well as the possibilities of supplying mankind with adequate mineral and power resources for future demands. Many great thinkers and scientists of present century assert that in the near future the globe will be covered with cities from one pole to the other with no agriculture to speak of and the world ocean dead mankind will have to depend on synthetic food.

The future demand of resources of the earth are based on following assumptions :

Population explosion and Agricultural resources

It is expected that by the end of the 20th century the world population will have increased from the present 3706 million to

6300 million at the present rate of growth. It would be erroneous to regard this demographic explosion as a factor affecting man's numerical influence on nature and seek ways to restrict the growth in the population. Indeed, during the first 70 years of the 20th century, the globe's popu'ation increased nearly 150 times as a result of its growing power resources alone. It is a question concerning the scope and character of man's influence on the environment. If this influence is compatible with the preservation of the natural balance in the environment, the catastrophe apprehended in respect of the future will never take place. According to the forecasts made by certain demographer, sociologists, scientists etc. the world population may reach 6300 million by this century. These forecasts are based on the assumption that agricultural production can provide enough food for the population by increasing the area of arable land from 4 billion hectares to 5–7 billion or 10 billion hectares at the most.

This forecast only reflects our present knowledge of food resources. There is no doubt that in the future these resources will be enriched and new, so far unknown, prospects for supporting life will be revealed. Even now in making forecasts of the food balance for the future, we take into consideration that the average daily diet of man will decrease as a result of reductions in the share of manual labour, increases in the number of people living towns or extension of urbanization, changing of dietary patterns, greater longevity of the population and smaller losses in the production and consumption of food-stuffs The share of other sources of food-stuffs, such as commercial fish-breading, will be somewhat increased. Oceans are the storehouse for the future source of human food. Scientists and oceanographers believe that the world ocean can supply food for as many as 30 to 50 billion people, while

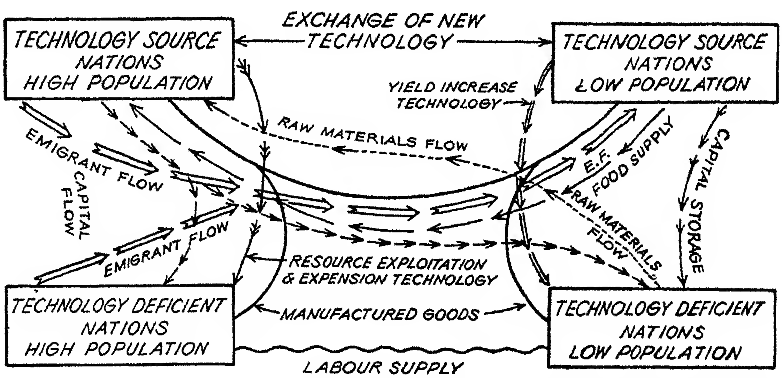

Fig. 2·8. A sketch model of World Food Production and Consumption System.

synthetic food-stuffs can satisfy the demands of all the people on the globe. The future productivity of agricultural plants can be

influenced basically in four ways : (1) manipulation of the genetic character of the plant, such as hybridization of corn and rich etc. : (2) Protection of plant against diseases and pests ; (3) improvement of water supplied to the plant ; and (4) addition of mineral nutrients to the soil. At present state of knowledge we shall assume that the technology-source countries of both low population-resources ratio and high population-resource ratio will provide sufficient food for their populations for an indefinite period in the future, either through domestic production or through foreign trade. Fig 2·8 is a sketch model of the world food production and consumption system.

Water Resources

There is another problem facing mankind, that of providing an adequate supply of water True, water resources in the form of the annual river flow are fairly large and reach 7,400 cubic kilometres per annum. The share which can betaken intoaccount for distribution is equal to 4000 cubic kilometres. This should be enough to satisfy the demands of the population for 100 years or more. At the same time, some regions have a surplus of water, while other suffer from an acute water shortage. With a population of 70 billion, the water deficient will reach 2,000 cubic kilometres. It is possible to compensate for this by controlling the river flow, extending the uniform use of water resources, utlilizing purified sump water repeatedly, diverting surplus water from rivers with excessive flow to regions suffering from water shortage, developing production processes which do not require high water consumption, desalinating sea water and precipitating evaporated moisture on the ground. Work in this field has already been initiated in various parts of the earth by various government.

Power Resources

Population growth leads to one more problem-that of generation of power with reduced use of combustion processes. The estimates of scientists indicate that fuel combustion releases tremendous amounts of heat as a result of which the heat and oxygen cycles on our planet may reach a critical stage as early as the middle of the 21st century. Although with thermonuclear power development the generation of power will be large enough to fully satisfy the demands of the population, it will be nccessary to restrict its use as well as that of other traditional fuels which above all, are valuable raw materials. The use of everlasting sources of power, such as the energy of the sun, wind and tides, which do not affect the heat and oxygen cycles of the earth and do not consume water, will be extended.

Mineral Resources

There is also problem of mineral resources with the ever-increasing rate of utilizing the earth's mineral wealth, they will reach their estimated life-term as the beginning of the 2 st century. However, there are other resources, such as the discovery of new

deposits, fuller use of the existing ores, all-round extraction of all the useful components of rocks, utilisation of waste products, etc. Secondary raw materials obtained from reconstituted products (nothing is wasted in nature) will be of great importance. Termendous reserves are concealed in the continental shelf and the depths of the world ocean. They are greater than all the known resources on land. These are the resources for future use, although their extraction has already begun. Furthermore, there are mineral deposits hidden at great depths under-ground which also belong to the future use.

All this indicates that with far-sighted and rational utilization, the earth's natural resources will be sufficient to provide for the further development of mankind.. However, for this purpose it is necessary to ensure the protection of nature all over the world, to use rationally the earth's natural resources and replenish them wherever possible. Further resources become productive to men mainly through the medium of culture. The comparative state of a country's technology, therefore, tells us something about the availability of its resources. The more advanced the technology, the greater will be the country's capacity to support people from the resources it has.

PART II

NATURAL RESOURCES

CHAPTER 3

NATURAL RESOURCES

Resources are Environmental Gifts

Each part of the earth is equipped by nature in certain ways that set wide or narrow limits upon its potential human use. It is the number, kind, and association of these items of natural endowment which help to establish the individuality of regions. Unlike climate and Landforms, they actually are used by man, and, because they either are obtained from the natural earth or exist in or upon it, they are called natural resources, or earth resources.

Mankind is subject to the same natural conditions as biotic resources, being dependent, directly or indirectly, on plant life for food, and always under the control of environment. In atomic age, there are no limits to the geographical distribution of human beings. Men can live in all the continents, and from the equator to the poles. Although the contrast between peoples and nations becomes more distinct, it may be traced in all stages of civilization. Stages of technological development of society and availability of resources acquire new importance, and indeed their existence and potency were first recognised by the way in which culture and civilization determine the higher powers of the mind. The intellectual as well as the physical unity of the human beings is strikingly shown by the fact that even amongst the most advanced peoples there are individuals who exhibit the untamed instincts of the savage, while in the most degraded society individuals with some higher powers and feelings occasionally rise above the level of the rest. By the use of reason mankind is able to modfy natural resources, and thus, consciously or unconsciously, to direct the course of development.

Civilization may be looked on as the result of men using their power of changing their natural resources, and regulating their technical know-how in order to increase the well-being of the community to which they belong. Each class of society appears to be capable of attaining a certain degree of mastery over themselves and their surroundings or on natural resources, this degree being much higher in the case of some society than in others. The position occupied by different groups of the human being with respect to civilization is intimately connected with their conceptions of new techniques and scientific inventions. Tribes of the lowest civilization live, as a rule, in a state of vague fear of evil spirits and of the ghosts of their ancestors, which they try to appease by worship and sacrifices.

The races lowest in civilization are most completely 'slaves to

their environment' exercising only the spritual powers. When the climate makes clothing unnecessary, and abundant fruit-bearing plants supply the means of life without labour or forethought, as in some tropical countries, although rich in resources but lack of capital and technical know-how, mankind is found in the least developed or most degraded form. On the other hand, where natural resources are limited, the climate severe, and the means of life only to be obtained by chance or success in hunting or fishing, the development of intelligence appears to stop short when the prime necessaries—food, clothing and shelter—are secured. The fur-clad Eskimo, feeding on blubber in his ingeniously - constructed snow house—Igloo—is certainly an advance on the naked, homeless savage of the tropical forests, who satisfies his hunger with fruits and insects. But both are so exclusively fitted to their environment that the Eskimo pines by the Mediterranean, and the forest Pygmy sickens and dies in the sunlit grass-lands. Scientific development appears to be stimulated by conditions and availability of resources which make life neither too easy nor too hard.

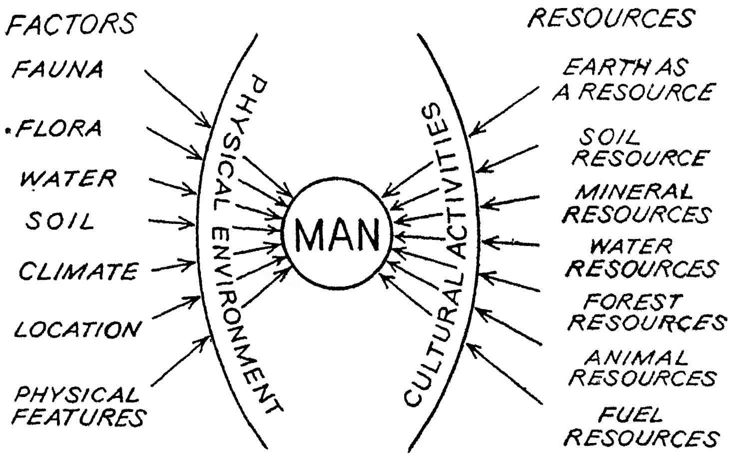

Fig. 3·1. Reciprocal Function of Man and Resources.

Much of Man's power in nature is evasive. It consists in devising methods of utilizing natural resources for the purpose of escaping uncomfortable consequences. By the development of new arts and new wants, by erecting a lofty structure of artifacts on the foundation furnished by nature, man provides the drive behind resource development and turns hostile wastes into cultural environments. While the universe may be finite and hence the totality of potential resources may be a fixed entity, that portion of the universe which at a given place and time is available for human use is not a fixed entity, but in constant flux. Every change in human want patterns and in social objective, every invention and increase in man's control over nature, constantly revises the criteria of availability

and ordinarily tends to enlarge the aggregate of available resources. Man and his resources are reciprocal in functions. Fig. 3·1 shows the reciprocal functional actions of man and natural resources.

Resource Classification

The two major classes of resources are renewable resources and non-renewable resources.

1. Renewable resources

There are some resources, of which man may use as much as he desires without fear that the supply ever will be exhausted. These may be called the renewable or inexhaustible resources. Water resources, air and solar heat are the example of inexhaustible or renewable resources.

2. Non-renewable resources

Those resources when once they are used, they are gone forever. These are called non-renewable or exhaustible or Fund resources. They are very scarce and their supply may be limited in quantity. not to replenish when they are used. Iron, coal etc. are the example of non-renewable resources.

Classes of Earth Resources

The material phenomena consist of the physical resources such

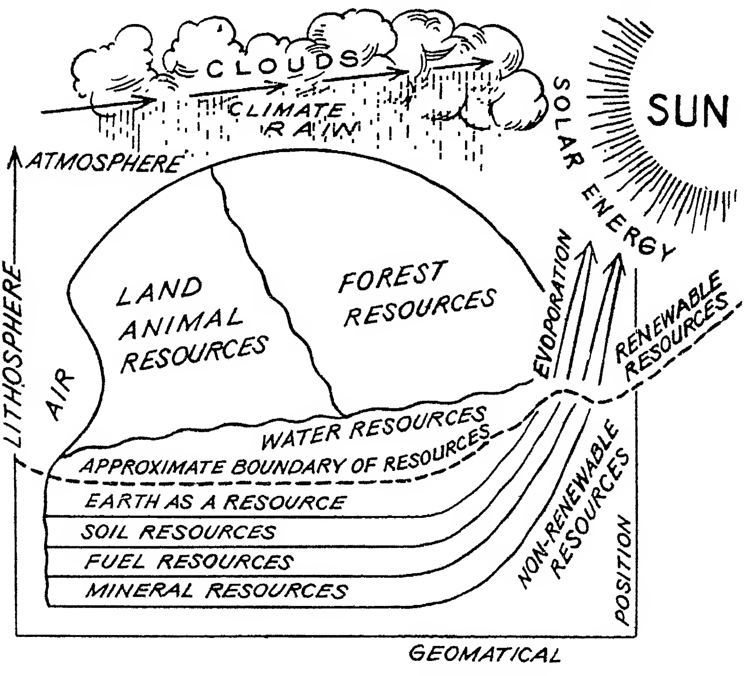

Fig. 3·2. Resources of the Earth

as land resources, soils, water, fuel and mineral resources; and the biotic resources which include natural vegetation or forest resources, native wild life and marine life. Erich W. Zimmermann would suggest that the word resource, "does not refer to a thing or a substance but to a function which a thing or a substance may perform.......[1]". The function, of course, is a raw material for industry or, in the case of the soil, in providing the media in which to proudce either the raw material for industry or the commodity for consumption. Natural resources have been defined as "...... all the freely given material phenomena of nature within the zone of men's activities......"[2] As the definition suggests, resources necessarily reflect human needs. The natural resources available for the use of man are of eight principal classes. They are :

1. Land as a resource
2. Soil resources
3. Water resources
4. Biotic resources : Further sub-divided into :
   A. Forest resources
   B. Animal resources
5. Mineral resources
6. Power resources
7. Human resources
8. Agricultural Resources.

Fig. 3·2 shows the important resources of the earth. The resources to be considered in the following chapters of this section of the book are (a) Land as a resource, (b) Soil resources, (c) water resources, (d) biotic resources (e) Mineral resources, (f) power resources and, finally (g) Human resources.

Conservation of Natural Resources

Some of the headlines printed in foreign newspapers sound like a SOS, "Mankind in Danger," "Nature Lays, Its Charge," "Ocean in Danger," "Before Nature Dies", etc. The concern about the environment, ecology, the depletion of natural resources, the population explosion and impending shortage of food has been mounting for nearly a decade and found world recognition in the United Nations Conference on the Human Environment held in Stockholm during 1972, Sept. and in its declaration that "the protection and improvement of the human environment is a major issue which affects the well being of peoples and economic development throughout the world." But there has not been such a dire warning as in the question posed by Sir Kingsley Dunham, Director of the Institute of Geological Sciences, in his Presidential address opening the British Association—meeting, "Can our Species" he asked, "survive the next few hundred years" ?

The question indicates that on the basis of accumulating, though still in exact and inadequate data, scientists are beginning to become alarmed, not merely at environmental damage or depletion

1. Zimmermann, E.W.—World Resources and Industries, p. 7, 1951.
2. Ginsburg. Norton, S., Natural Resources and economic development' AAAG. vol. 47, 1957, p. 204.

of natural resources and food resources for an exploding world population, but for the chances of the survival of the human race. Disaster to the human race can come from the forces of Nature as well as from the changes effect in Nature by Man in pursuit of richer life. The first, such as the movement of the earth's crust which produces earthquakes, volcanic eruptions and the sinking, rising or collisions of land masses is beyond man control. The atmosphere and hydrosphere can only be partially controlled by man. But changes in either can effect humanity in terrible ways. The ebb and flow of glaciers from the Poles is an example. But what worries the great thinkers and scientists most are the changes effected in Nature by Man and his technology which fortunately are controllable, though not yet controlled. The most imminent is the ever growing use of fuel resources. Research in Sweden has indicated that combustion of fossil fuels will increase carbon dioxide in the atmosphere by 18% by the year 2000, producing the dreaded greenhouse effect. If every country in the world succeeds in achieving a standard of life equivalent to that of the United States today, the temperature of the atmosphere and the seas would rise to an extent endangering human life, and melting of Polar Ice caps and drowing much of the land surface. Many other danger signals are the quickening depletion of non-renewable energy sources and mineral resources essential for todays industrial civilization and the limited scope for expanding food production to keep pace with the population increases. Some important metals may run out over a longer period but recycling and reuse may extend the period of availability. The limit of food production will be reached if population growth continues at the present rate—the UN estimate is 6300 million in year 2,000 from 3706 million in 1970.

True, in many parts of the world, the area of land subject to erosion and taken over for construction is extending. Pollution of the atmosphere and water is increasing, fish-stocks are decreasing and timber-felling in certain countries is proceeding at a faster pace than the natural growth of forests. The dependence of present civilization upon certain earth resources has grown so rapidly in recent decades "that in a hundred years the output of pig iron, copper, and mineral fuels has increased a hundredfold, that more mineral resources have been mined and consumed since the opening of the present century than in all preceding history".[1] The modern civilized man ruthlessly exploited the hidden treasures of the earth and destroyed the ecological cycle in the name of scientific progress.

Does this mean that the growth in the population and the irreversible process of industrial development must be stopped ?

Perhaps, all these alarming reports are salutary in one respect. Certain measures to protect nature are being taken under public pressure. For instance, Rachel Carson's *Silent Spring* has impelled the US Government to prohibit the use of DDT in agriculture.

1. Leith, C.K., World Minerals and World Politics, p. 3, 1931,

Recently, an inter-governmental conference to protect the world ocean from pollution was held in London. It was attended by representatives of eighty countries, including India. The convention it adopted prohibets the dumping of hazardous industrial waste products into oceans and seas. But it is suggested that true conservation must go much further than this. "If we regard the natural resources as a part of our heritage, then the protection of that heritage assumes something of an ethical quantity. True conservation policies are, therefore, designed to make a greater provision for the future than the market mechanism or any procedure based on the imputation of market values would allow. It is in order to insure this degree of protection that the state often formulates policy to be followed in the extraction and use of resources"[1]. The essence of conservation, to quote the assessment of a well-known American economist, "is the sacrifice of present economic interests on behalf of posterity"[2]. However, these measures cover only some aspects of the general problem. The task, in fact, is more complex and comprehensive : to combine the rapid development of production forces with the rational use of natural resources.

The appraisal of resources varies with the stand-point of the individual and of organised social groups. A number of factors contribute to the becoming of resources. Among the most important, is the dependence of resource values on the stage of technological development of the society using the resources. The social appraisal of the environment as the basis of group continuity reckons with longer time units, takes a longer range and hence tends to favour a slower tempo of exploitation and often also a fuller utilization of resources. In time, however, the social appraisal of resources as the basis for the fulfilment of social objectives assumes increasing significance.

"The two extremes appear in nineteenth century United States, with its unrestrained individual exploitation of resources, and in Soviet Russia, with its insistence upon the planned social utilization of resources"[3].

The Soviet Union is the first country in the world to have fixed a limit for the concentration level of noxious substances in the atmosphere. In the U S.S.R.; it is prohibited to put new industrial enterprises into operation if the development of purification facilities has not been completed. Furthermore, there are laws for the protection of soil and water. Measures connected with the protection of nature and the replenishment of certain natural resources are included in long-term plans for economic development.

Ecological issues in the industrially advanced countries have moved up on the list of priorities because the other items on their socio-economic agenda have more or less been resolved. But

1. Duncan, Craig. Resource utilization and the conservation concept, Eco Geog , Vol. 38, p. 117. 1962.

2. Zimmermann, E. W., op. cit. p. 810.

3. Op. cit.

poverty and development are still the dominant concern in the developing countries. They are going to be so for a long time to come. It is not being suggested that ecological issues are the concern of the idle rich. The environmental problems of the developed countries are indeed real.

What greater crime is there than to poison the air that people breathe and the water they drink ? How then can the wise men of the west urge conservation of forests and mineral resources. The millions of people living in slums in the poor countries are themselves deprived ? When their own lives are contaminated at the source, how can one expect them to keep the oceans the rivers and the air clean ? In the developing countries the major concern, naturally, is and should be to accelerate socio-economic development. And a meaningful ecological policy must not hamper the attainment of that goal in the most expeditious way.

Any one can notice that this advice to the developing countries is not entirely altruistic. The unconcealed concern for the fast depleting natural resources of the earth is the primary motivation. The application of technology in the industrially advanced countries has led to a serious shortage of mineral resources. The environmental scientists at Stockholm Conference was made clear that it was the developed part of the earth that was being depleted fast, and it was this area that polluted most. The cost of the cleaning up the world, it was argued, must be borne by the industrialised nations. Also, since these countries had reached their present state of affluence by exploiting the natural resources of the developing countries, most of which were their former colonies, the industrially advanced countries in fact should make amends.

In the past five years, several other decrees aimed at purifying the environment and improving the use of natural resources have been passed in the world. They iuclude, for instance, measures for protecting the sea against pollution, for preservation of the pollution of the river basins, preservation of fuel and mineral resources, etc All this undoubtedly contributes to the creation of optimal conditions for the life, work and recreation of the working people. In September 1972, the Environmental Scientists at Stockholm, took several decisions on improving the protection of nature and the rational use of its resources.

There is no doubt that there is far greater awareness of the problem of environmental pollution and ecological imbalance than ever before and such awareness is daily growing. A variety of converging psychological factors are no doubt at work in this growing awareness and even obsession with the ecological problem. People who are out of love with affluence because of surfeit and the triviality that is has bred and simple—lifers, genuine and phoney, have joined hands with those who have found empirical evidence of danger to life from the reckless disturbance of the ecological balance by over–exploitation of the earth's resources and hidden treasures of the earth.

Whether or not fact the richer countries can afford a philosophy of this kind, it is plain that the poorer countries cannot. Poverty is the worst form of pollution. In addition, the ecological problems of these countries are different from those of the richer countries, though the process of industrial development has super imposed problems like air pollution and disposal of industrial wastes. The concept is that the developing countries must evolve their own ecological philosophies and strategies. The real task is to improve the quality of life. Economic planning must comprehend conservation of natural gifts and natural resources, of whatever is of value in the past, and regional and spatial planning that ensures contentment with growth.

CHAPTER 4

THE RENEWABLE RESOURCES

There are some Godly resources or gifts, of which man may use as much as he desires without any fear that their supply will not be exhausted. The resources of this class are found those gaseous, liquid or any other component that have direct value for every human beings. These resources are the basis for the production of many other necessary goods. They are known the renewable resources or also called inexhaustible resources.

Classes of Renewable Resources

The renewable resources available for the use of man are of five principal classes. They are :

1. Solar heat,
2. Air,
3. Water resources,
4. Forest resources,
5. Grasses.

These resources to be considered in this section of this chapter are Solar heat and Air. Solar heat and air are pre-eminently the supreme renewable resources—even more so for man than non-renewable resources of coal or gold.

Source of Solar heat

Sun is a prime source of renewable resource of Solar heat. Sun is a central body of the Solar system, a luminous sphere approximately 384000 km. in diametre ; it is believed to consist of a liquid inner portion with a gaseous outer covering. The average distance of the earth from the sun is about 148,800,000 kilometres. All forms of life on the earth and on other members of the solar system are dependent upon the radiation from the sun for their existence. The heat of the sun is the great source of all activity and all life on our earth, and its principal effects are accumulated where the atmosphere and the crust of the earth are in contact. The heating surface of our atmosphere is the surface of our earth. It is fortunate for man that only the polar regions and high latitudes receive insufficient heat energy from the sun for significant development. Since the sun lies low on the horizon in these high latitudes even during midsummer, the rays of energy strike the earth obliquely, resulting in extensive heat dispersion. Further heat loss takes place in the passage of these rays through the atmosphere, the air absorbing and reflecting to outer space much of the insolation which would otherwise have reached the ground. Toward the

equator, on the other hand, the angle at which the sun's rays strike the earth's surface is less oblique ; the rays, therefore, undergo less surface scattering. Fig. 4·1 shows the effect of relative obliquity of the Sun's rays on solar heat or insolation.

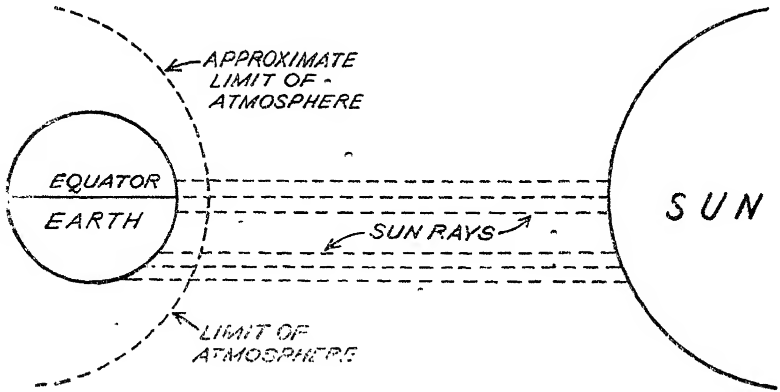

Fig. 4 1. Effect of obliquely of the Sun's rays on Solar heat

The bright disc of the sun is termed photosphere consist of great outbursts of intensely heated gas mainly hydrogen, generally called prominences. Prominences have been seen rising to the height of 640000 kilometres above the Sun's surface in a few hours, against gravity 27 times as powerful as that of the earth. This gives us some idea of the terrific violence of the manifestations of solar energy. Down-rushes of comparatively cool gases from the upper regions of the Suns atmosphere are believed to be the cause of black marks which are often seen in the photosphere and termed sun-spots, although sometimes many thousand kilometres in diametre. Solar radiation or the amount of the solar heat increases and decreases according to the number of sun-spots. These sun-spots are great vertices in the atmosphere of the Sun, revolving sometimes in one direction and sometimes in the other. Photographs of the Sun's disc are taken daily in some astronomical observatories in order to preserve a record of the number and movements of Sun-spots, and in this way much information has been obtained on the subject. It has been obereved that sun-spots usually originate at some distance on either side of the sun's, equator, and for a time they increase in size ; then beginning to diminish they travel toward the equator and gradually vanish, being succeeded by others, which are smaller and fewer. Finally, after about twelve years or so, the whole set fades away, and a new series of larger size appears and goes through the same changes. Periods when sun-spots are at a maximum succeed each other at intervals of about eleven years, and relation's have been traced between them and the influence of the sun's radiant energy on the earth. During total eclipses a halo of silvery light, sometimes

circular, sometimes spreading out like great wings surrounds the sun. It is called the corona, and is probably composed of fine particles of dust either thrown off by the sun or being attracted toward it and shining, in part at least, by reflected light. The sun is a hot gaseous sphere. Its interior is not accessible for direct observation and can only be studied theoretically. The gas above the photosphere is much more tenuous and transparent and is called the atmosphere. It is divided into : (a) the Chromosphere, a layer several thousands of kilometres thick and red in colour owing to hot gaseous hydrogen. Prominences erupt from the Chromosphere to heights of thousands of Kilometres, or project almost motionless above it; (b) the outer atmosphere, or corona, which is divided into the F corona or outer corona and the K or inner corona, which is shown in fig. 4·2.

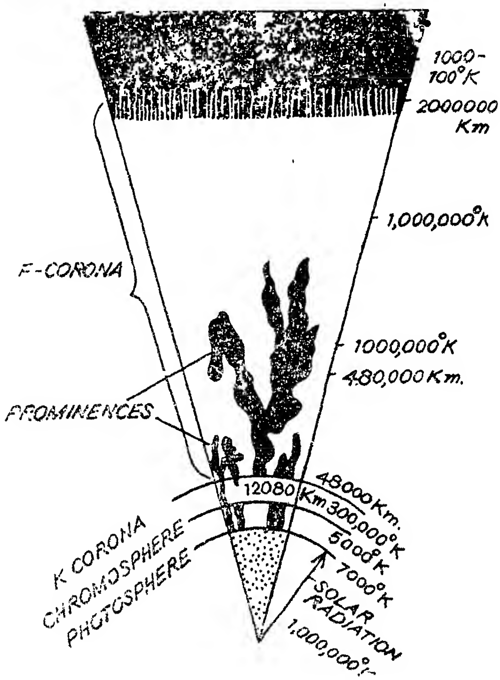

Fig 4·2. Section through the part of the sun and its atmosphere

The Heating of the Atmosphere

The earth's surface gets heat from various sources, but that received from the sun is far greater than that from all other sources. That much heat is received from the sun is shown by the fact that the temperature generally rises and falls when the sun rises and falls or when the sun goes down. It is also shown by the fact that the temperature is generally higher on a sunny day than on a cloudy one.

The sun heat is the great source of renewable resource in a form of energy on the earth's surface. The sun whose diameter is more than one hundred times the diameter of the earth, and whose temperature is estimated to be more than 30,000,000°C. It. therefore, gives out tremendous amounts of energy all round in a form of renewable resource. The earth catches only about 1/200,000,000 part of this energy. Even though insignificant when compared with the total sent out by the sun, this renewable energy in the basis of all life and all activity on the face of the earth. Between the earth's surface and the sun, however, lies the atmosphere. The solar energy must, therefore, pass through the atmosphere.

The radiant energy received from the sun by the earth is known as insolation. It varies considerably over different parts of the earth's surface. It differs from place to place and from time to time due to the following factors :

1. Relative obliquity of the sun's rays,
2. Length of the days,
3. Aphelion and perihelion stages of the earth, and
4. Relative distribution of land and sea masses.

The total insolation per day is not a maximum at the latitude where the sun is highest at noon, but at a rather higher latitude where the daily duration of sunlight is greater. For the year as a whole, however, insolation is greatest at the equator, it decreases at first slowly, then more rapidly, then slowly again towards the poles. Insolation shows the least variation throughout the year at the equator, and varies very considerable at the poles. Table - ·1 shows the total annual insolation for various latitudes expressed in thermal days, is taken from the Physical Elements of Geography[1] :

Table 4·1

Total annual Insolation at various Latitudes

Latitude	Thermal days
0°	365·2
10°	360·2
20°	345·2
30°	321·0
40°	288·5
50°	249·7
60°	207·8
70°	173·0
80°	156·6
90°	151·6

1. Finch, V.C. & Trewartha, G.T., op. cit. p. 30,

Processes of Heating of the atmosphere

There are three ways in which air receives, loses and transfers heat. The earth's atmosphere is seen to be warmed by radiation, by condition and by convection, just as the stove warms the air in a room in these three ways. At night and in winter the air is cooled by radiation and also cooled by contact with the ground. Radiation is interfered with by vapour and dust in the air, so that more heat is retained in the lower atmosphere on hazy and muggy days than in clear, dry weather.

The main process in the heating of the atmosphere is, for our purposes, the conduction of heat from the heated surface of the earth to the layer of the air that lies in contact with it. The heated air expands in volume and moves, leaving room for the cooler air to slide down to the heated body and be heated in its turn. Air currents are an important feature in the heating of the atmosphere.

The transmission of heat from one part of a liquid or gas to another by the movement of the particles themselves is called convection. A familiar example of convection is the upward movement of air which has been heated by contact with the earth's surface, this aid is said to rise in a convection current.

Radiation is the main process of heating the earth's surface. Radiant energy is constantly emitted in all directions by the sun, some of this reaching the earth and being converted into heat, the earth it constantly losing heat into space by radiation. The radiation we receive from the sun in the form of light and heat comes from its deep interior, where it is generated by nuclear reactions. The main process is probably the proton chain. The list of elements occurring in the sun's atmosphere are given in the table 4·2.

Table 4·2

Elements occurring in the sun's atmosphere[1]

Element	Percentage number of atoms	Mass (milligrams per column of one sq. cm. section)
Hydrogen	81.760	1,200
Helium	18.170	1,000
Carbon	0.003,000	0.5
Nitrogen	0.010,000	2.0
Oxygen	0.030,000	10.0
Sodium	0.000,300	0.1
Magnesium	0.020,000	10.0
Aluminium	0.000,200	0.1
Silicon	0.006,000	3.0

1. Goldberg and Aller, Atoms, Stars and Nebulae, 1956.

earths atmosphere, the earth being at its mean distance from the sun. Its value is approximately two calories per sq. cm. per minute.

Only a very small percentage of solar energy is intercepted by the planets, including the earth. By for the greatest part of it disappears into interseller space. The total quality of energy emitted annually is 3×10^{33} calories, that is—

30,000,000,000,000,000,000,000,000,000,000,000.

We believe that this output of energy has been going on four thousands of millions of years and there is not the slightest indication that it is decreasing even slowly. Calculations show that this output is much greater than could be accounted for by the cooling of originally hot matter, by combustion or by bombardment by meteorites. It was formerly believed that the release of solar energy was the result of slow contraction, but this source too is realized to be quite inadequate.

This energy is now thought to be due to nuclear processes in the interior of the sun, hydrogen being converted into helium. The energy thereby released, *e g* in the form of gamma rays of very short wave-length, is changed on its journey to the sun's surface by alternate absorption and emission by matter, into radiation of longer wavelengths, part of which reaches us as visible light.

The radiant energy received from the sun, transmitted into by three wave lengths. These are :

1. **Short wave radiation**—These waves are known ultra violet rays and travelling at the rate of 2,94,000 km. per second. Wave length to 1/250 to 1/6700 millimetre or in scientific terminology it is 0·4 u. (u for micron that is ·001 millimetre).

2. **Medium wave radiation**—Their total length is 0·4u to 0·8u. These are multi-colour rays.

3. **Long wave radiation**—These are known as infra-red rays and their length is over 0·8u. (That is generally 10u to 15u and this radiation is therefore called long-wave. The wave length of radiation varies within very wide limits, but the radiation that is of importance to the energy balance of the earth all falls within a relatively narrow range. The radiation from the sun is being examined by the Smithsonian Institution of high altitude stations in California, Chile and Sinai. The amount of solar energy in various latitudes also varies. Table 4·3 shows the average amounts of diffused sky radiation expressed in gram calories/cm.^{2}/minute.

Table 4·3

Diffused Sky Radiation cal./cm.^{2}/minute.

Day	0°–10°	10°–20°	20°–30°	30°–40°	40°–50°	50°–60°	60°90°
Dec. 21	0·091	0·079	0·066	0·052	0 034	0·016	0·001
Mar. 21	0·108	0·105	0·099	0·093	0·083	0 066	0·047
June 21	0·105	0·114	0·124	0·125	0·126	0·122	0 153
Sept. 21	0·107	0·104	0·097	0·091	0·081	0·065	0·048

The average amount of solar energy received at various latitudes is given in Fig. 4·3. The minimum and maximum solar heat can be summarized as follows :

Heat gained by	Maximum (Cal /cm.^{2}/min.)	Minimum (Cal./cm^2/min.)
Condensation of water vapour...	·086	·086
Conduction of heat from the earth's surface	·010	·010
Absorption of radiation	·180	·090
	·276	·186
Heat lost by radiation	·276	·186

It has been calculated that only 14 percent of the sun's radiation is absorbed directly on its passage through the atmosphere, 2 percent is reflected from the earth's surface, 6 percent is reflected

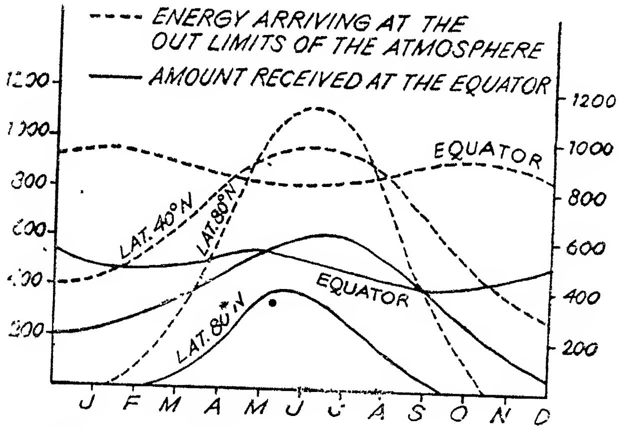

Fig. 4·3. Solar Energy at various latitudes.

from the atmosphere, and 27 percent is scattered and reflected back into space by the upper surfaces of clouds, assuming a worldwide mean cloudiness of about 50 percent. The remaining 51 percent of solar energy reaches the earth's surface as direct solar radiation. This and the scattered radiation from the sky are the main portions of solar radiation available for the earth's heat budget, which is shown in Fig. 4·4.

The flow of Heat

We know that water and air will only flow from a region of high pressure to a region of low pressure. Similarly heat will

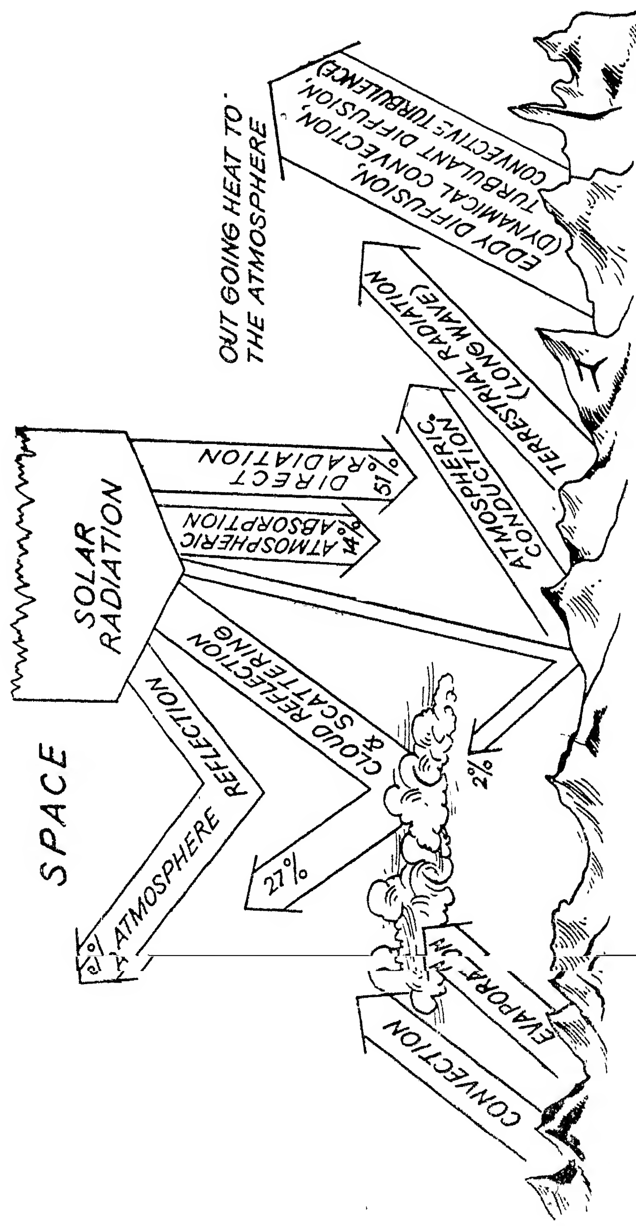

Fig. 4·4. Solar Energy available for the earth's heat budget.

only flow from a region of high temperature to a region of lower temperature. Therefore when a body is at a high temperature

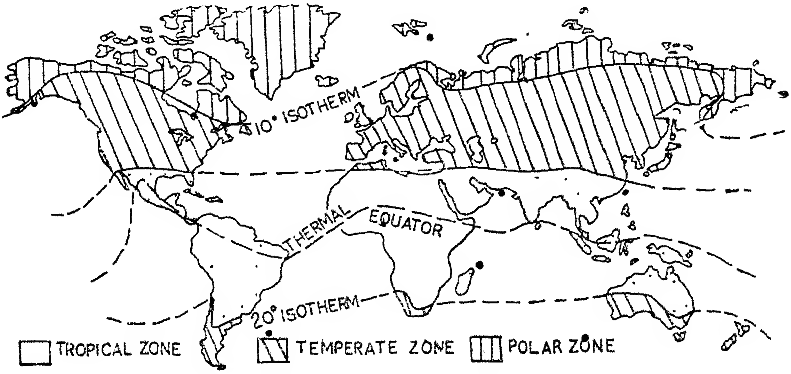

Fig. 4·5. Thermal Zones.

than its surroundings, heat will flow it to its surroundings. The changing of one form of energy into another—A characteristics of energy is that it can be converted from one form to another. The heat energy from the sun evaporates water from the sea and is converted to potential energy of water in the cloud. The hydro-electric generator converts the mechanical or generally called kinetic energy of the running water into electrical energy. A household electric bulb converts electrical energy into heat or light.

It follows that the region between the tropics receives most of the solar energy, higher latitudes sharing it in smaller and smaller proportions. The whole earth has consequently been divided into thermal zones which is shown in fig. 4·5. The areas within the Polar circles, poorest in radient energy, are termed the Frigid zone, those between the polar circles and the Tropics, where there is a tolerable abundance of radiation, the temperate zone, and the wide belt between the Tropics which is overflowing with solar heat the Torrid

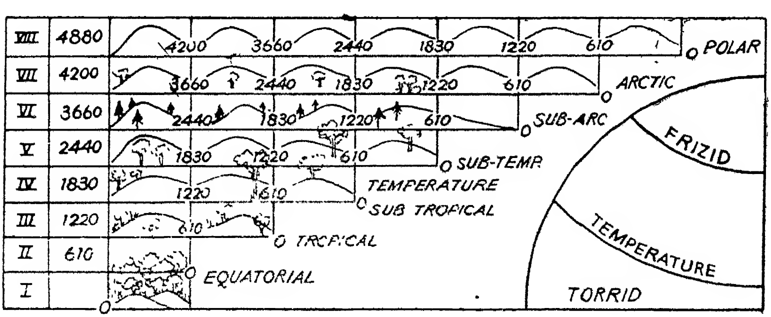

Fig. 4·6. Climatic and Vegetational zones of the earth.

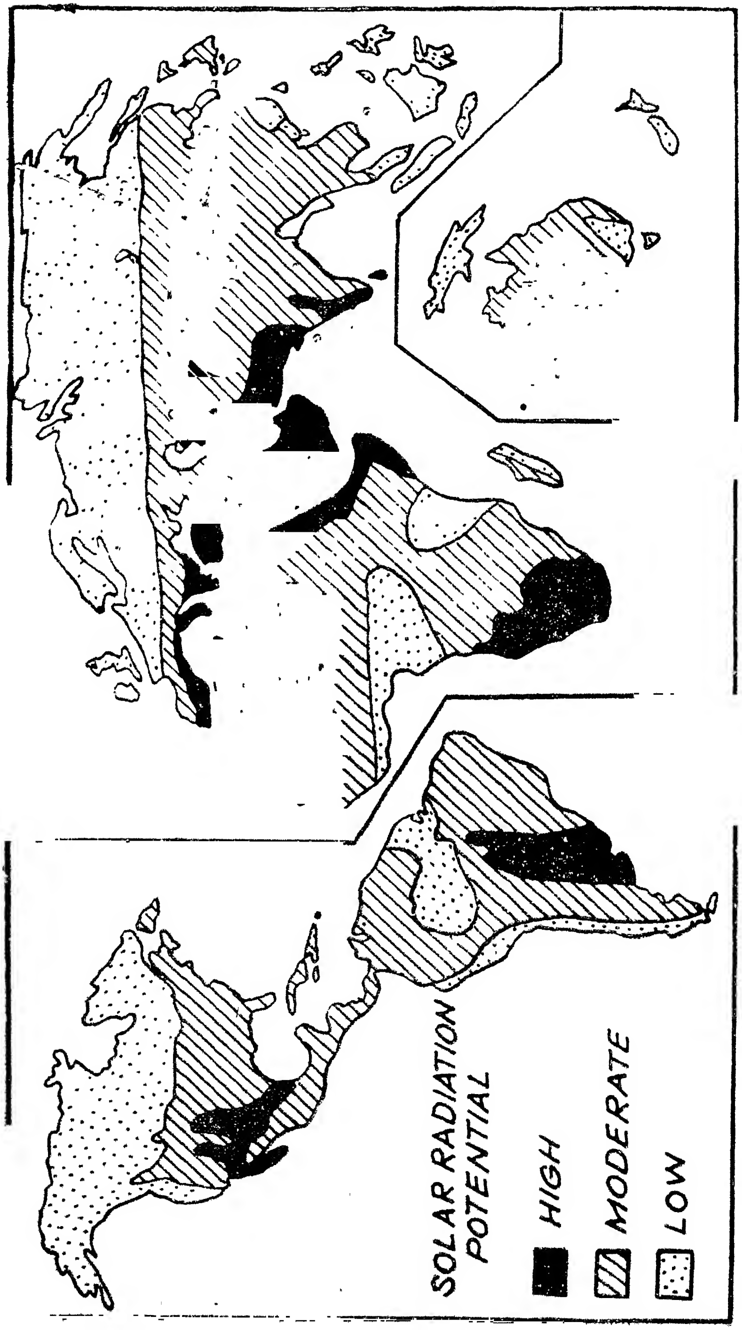

Fig. 4 7. Potential Sun power regions

zone. The climatic and vegetational zones according to availability of solar heat is given in fig. 4·6. If the earth were a smooth lithosphere, surrounded by a continuous hydrosphere and atmosphere, this unequal distribution of solar energy would give rise to a regular system of redistribution by currents streaming from the equator to the poles in the upper regions of the atmosphere, and from the poles to the equator in the lower, their paths curved in consequence of the rotation of the earth, and in this way the tropical warmth would be distributed with some approach to uniformity over the whole surface. Fig. 4·7 shows the potential sun-power regions of the world.

The wind is the oldest type of energy known to man, but is used so little except by sailing vessels; power from the tides is hardly exploited, and there is apparently only one plant in France, which uses this form of energy. About 18 litres of water can give the same amount of energy as one litre of petrol, and in near future the solar heat of tropical countries could be conveyed by pipeline for use in temperate and arctic lands.

CHAPTER 5

LAND RESOURCES

Land is the prime resource for man. Since the beginning of human existence man has directed his activities with reference to earth resources and he know how to use for his own benefit.

Characteristics of Land Resources

About 72 percent of the whole surface of the globe is covered with water. The actual extent of this vast expanse is estimated variously by different authorities, but for our purpose it will be sufficient to say that it is about 379 million of km² out of the total of 512 million. It is not distributed equally over the whole surface of the Planet; there is far more land in the northern than in the southern hemisphere.

By far the greater part of the earth sphere is the solid lithosphere, a body of rocky material with an Equatorial diameter of 12,756 kilometre, a polar diameter of 12,713 kilometre, a circumference of about 40,000 kilometres, and a total volume of about 416,000,000,000 cubic kilometres. The following table 5·1 shows the certain important facts of the earth.

Table 5·1

Important Facts of the Earth[1]

Approximate age of the Earth	4500.000,000 years
Total area of the earth	512,070,000 km²
Total land hemisphere on the earth	149,526,000 km²
Total water hemisphere on the earth	362,544,000 km²
Equatorial circumference of the earth	39,843 kilometres
Polar circumference of the earth	39,746 kilometres
Total volume of the earth	416,000,000,000 cub. km.
Total weight of the earth	5,887,613,230,000,000,000,000 tons
Polar diameter	12,713 kilometres
Equatorial diameter	12,756 kilometres
The speed of the earth per hrs.	29·6 kilometres
Equatorial speed at axis	1600 km. per hrs.
The earth revolves round the sun at her axis (per hrs.)	106,200 km.
Total length of the elliptical orbit of the earth	928,000,000 km.
Distance of the earth from the sun	148,800,000 km.
Time taken to revolve round the sun	365¼ days
Consumption of energy per year (Solar energy)	14·9 tons
Distance at the time of perihelion	146,400,000 km.
Distance at the time of aphelion	151,200,000 km.
Solar insolation on the earth	1·94 cal/cm²./min.

1. From various sources.

Average thickness of atmosphere from earth's surface	10,480 km.
Average annual rainfall on the earth	999·6 m.m.
Average specific gravity of the crust	2·7
Specific gravity of the earth	5·66
Average pressure on earth's surface	1113 millibars

Geographical Area

Every consideration of geographical area must take as its starting point the 512,070,000 km² of the earth's surface. Though some 21,000,000 km² about the poles remain unexplored, and only the twenty-eight percent of the total constituting the land area is the actual habitat of man, still the earth as a whole is his mother or home of a man. Its surface fixes the limits of his possible dwelling place, the range of his various economic activities, the distribution of animals and plants or biotic resources and availabilities and accessibility of natural resources on which he must depend. These conditions he has shared with all forms of life from the amoeba to the civilized nation or people. The earth as a resource is the primal and immutable condition of earth-born, earth-bound man, it is the common soil whence is sprung common humanity. Humanity's area or *oikoumene* forms a girdle around the earth between the two polar regions, and embraces the Tropics, the Temperate zones, and a part of the North Frigid, in all five-sixths of the earth's surface. This area of distribution is unusually large. Only about 125,000,000 km² of the oikoumene is land and therefore constitutes properly the habitat of man. The most progressive peoples today find their scientific, economic, religious and political interest embracing the available land resources of the world.

The habited areas of the earth's surface are the real land resources. The prevailing continental form is a south pointing triangle, the longest side of which runs in a direction a little east of south. Table 5·2 shows the north-south and east to west dimension of each continent.

Table 5·2
Continental Dimensions

Continent	North-South Dimension in kilometres	East-West Dimension in kilometres	Area km²
Africa	7280·0	7920·0	28,507,500·0
South America	7360·0	5040·0	19,006,000·0
North America	8160·0	6400·0	21,397,500·0
Europe	4000·0	5440·0	9,590,000·0
Asia	8560.0	9600·0	31,925,000·0
Australia	1680·0	3776·0	7,435,000·0
Antarctica	5566·0	----	12,805,000·0

In each pair of continents the northern, has a wide extension from east to west, a deeply indented coast, and a great group of islands on the south-east stretching toward the unindented coast of the southern member, which, as a rull, extends from north to south, and has an island or island group lying to the south-east.

If a glance is set on the relief map of the world as shown in the following table 5·3, the student will be able to compare the characteristics of the separate continents.

Table 5·3
Comparison of the Continents

Continent	Asia	Africa	N. America	S. America	Europe	Australia	Total
Area (Million km²)	31·9	28·5	21·3	19·0	9·5	7·4	118·6*
Average height (metres)	915	610	577	610	280	243	639
Highest point (metres)	9069	5644	5843	6709	5638	2193	8859
Surplus coast (%)	61·7	28·3	64·3	32·6	87·6	30·6	—

*Omitting Antarctica and Arcatica.

The available land resources within zones of equal altitude is given in table 5·4.

Table 5·4
Percentage of available land resources in various continents within zones of equal Altitude.

Continent	Asia	Africa	N. America	S	Europe	Australia	Total	Remarks
Over 3650 metres	5·8	0·4	0·7	4·4	0·2	0·0	2·6	Snow Covered.
1830–3650 metres	10·0	2·8	8·4	5·0	1·7	0·3	6·0	Steep Slopes.
915–1830 metres	21·8	21·8	13·2	7·0	5·5	1·5	17·0	Rugged.
450–915 metres	21·7	27·6	13·3	16·8	10·0	4·1	19·3	Available land resources for human use.
180–450 metres	16·0	34·8	32·1	26·8	27·0	64·3	27·8	
0–180 metres	23·3	12·5	32·25	40·0	53·8	29·8	26·7	
Below sea level	1·4	0·1	0·05	0·0	1·8	0·0	0·6	Flooded areas.

The above tables clearly show that the great diversity in the distribution of available land resources over the earth, it is not surprising that large states often have a good share of them. A broad geographical base means generally abundant commond of the various resources. Thus, with its large size, the United States of America can depend on the production of many different regions; food resources from the drier interior, forest resources from the mild and most south and pacific north-west, mineral or fuel resources from central and north east and the like. The United States with about 6% of the world's population enjoys over 40% of world income. On the other the size of the U.S.S.R is so large that it necessarily includes a great range of climates and variety of natural resources. Its area include every variety of natural and biotic resources and originally every degree of cultural development.

Larger states also have room for larger populations. Such as Brazil, no country in the world possesses so large proportion of land available for the support of human life and productive industry. In the same way the continent of Australia has vast potentialities and unexploited natural resources for future generations. In short the larger the area occupied by a race or people the surer the guarantee of their permanence. The abundant natural resources awaiting development in such big countries give to the mind of the people an essentially practical bent.

Among the different countries of the world, the U.S.S.R. has the largest and the Monaco has the lowest in size. Besides the U.S.S.R., People Republic of China, Canada, Brazil, Australia, U.S.A. etc. are the other countries whose area vary in size. These are as follows :

Table 5·5

Largest sized countries

Countries	Area km²
U.S S.R.	21,751,600
Peoples Republic of China	9,230,000
Canada	9,014,200
Brazil	8,517,600
Australia	7,735,000
U.S A.	7,732, 00
India	3,276,141
Argentina	2,808,000

Smaller sized countries must always be weak economically as well as politically, where as a gigantic country is characterized by a huge internal commerce and a comparatively large per capita foreign trade. There are two great world powers, one is capitalistic and second is socialistic block due to gigantic size of their

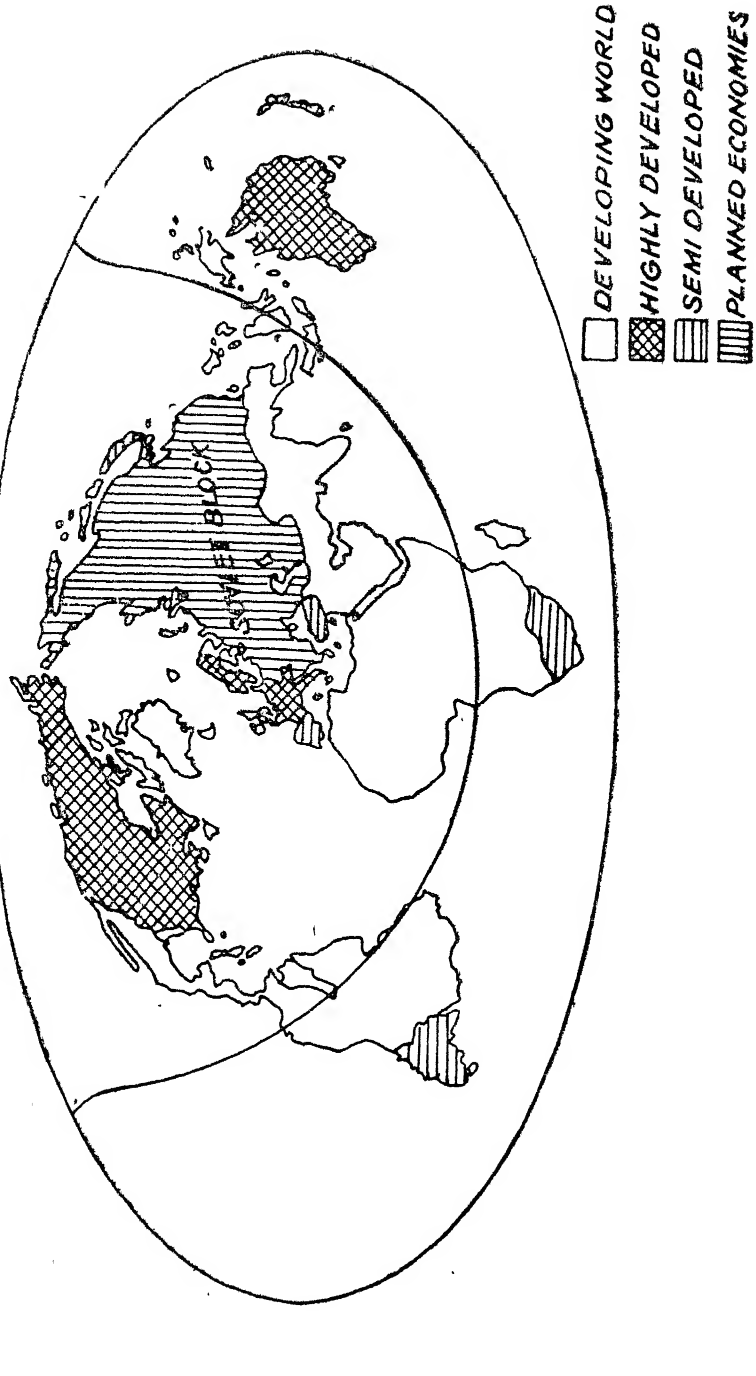

Fig. 5·1. Developing countries

state, economies and availability of resources. Together, they control 22% of the earth's land surface and 15% of its population. It appears from table 5·6 that three of the major power nations of the world are gigantic in size, indeed, if the British and French empires be included with the mother countries, then all the major powers are gigantic in areal magnitude.

Table 5·6

Land resources and % share in world trade

Major Powers	Area Km²	Percentage share in world trade Import	Export
U.S.S.R.	21,751,600	4·09	4·34
China	9,230,000	N.A.	N.A.
U.S.A.	7,732,400	10·85	14·52
France	563,800	5·25	5·40
U.K.	244,400	7·95	7·10
Minor Powers			
Brazil	8,517,600	N·A.	N.A.
Turkey	769,600	0·29	0·25
Japan	382,200	4·15	4·54
Italy	306,800	3·75	3·86

These above mentioned countries are now the leaders of the world in various fields of learning and human enterprise. Except the U.S.S.R. which ranks second followed by the United States, most of the other socialist countries of Soviet block occupy an intermediate position in between developed and developing countries in terms of many economic indicators. The peoples Republic of China on the mainland also belongs to the Socialist world although its economic link with eastern Europe appears to have loosened in recent years and it looks like as if it is creating third world in African countries for itself.

The developing countries of the world occupying practically the whole of Africa, except its southern portion (Republic of south Africa), the whole of Latin America and about three-fifths of Asia, as shown in fig. 5 1. Thus they have between then about one-half of the land resources of the earth and about the same proportion of human resources. Highly developed civilizations had flourished in each of the three continents in the past when the rest of the world was passing through dark ages.

Many of the nations of the present-day developing world notably Indians, Chinese and Arabs were more than match for the developed nations of today in the bygone days. Their discoveries and contributions in various fields of knowledge had enriched the ancient and medieval world in no small measure. In the second

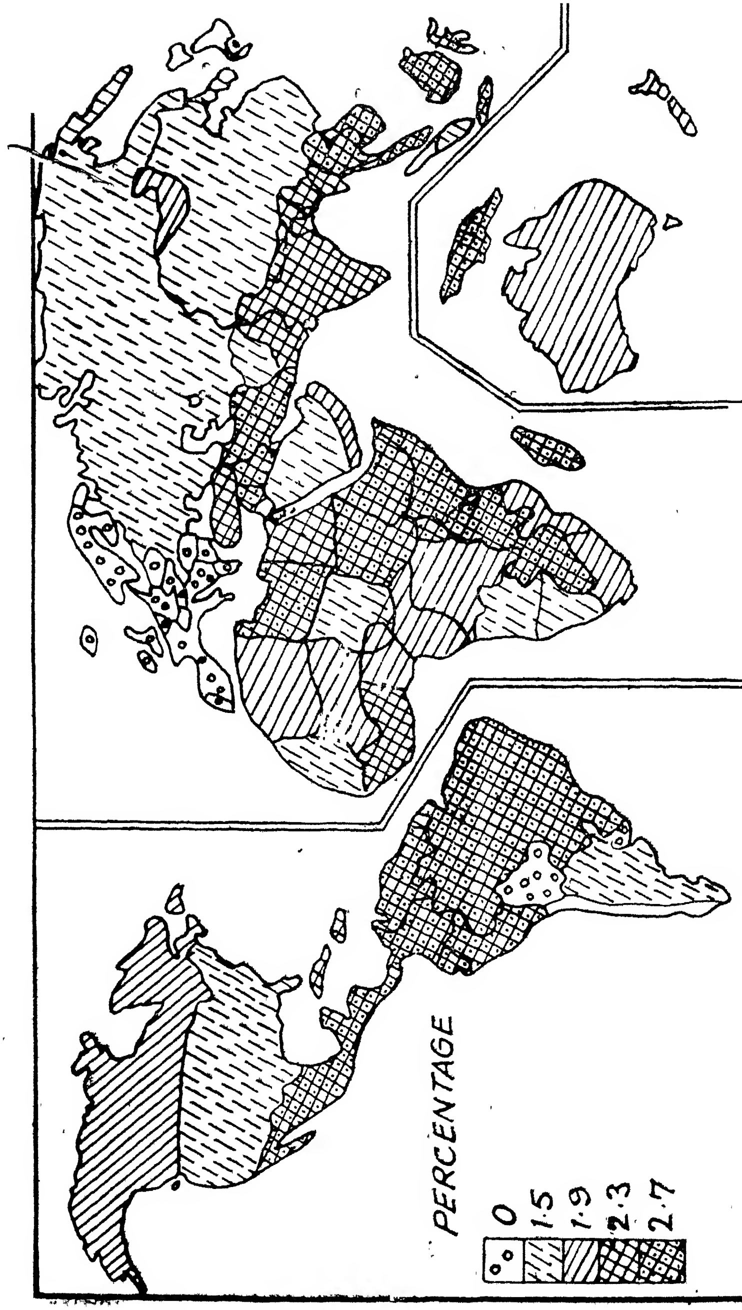

Fig. 5.2. Growth of Population

phase of their history many of them were subject to foreign domination and exploitation, becoming poorer and poorer through passage of time. Now that they have gained independence, they are prepared to wipe out the signs of under development such as high rates of population growth, low national income, unemployment and underemployment, preponderance of the agricultural sector and its low productivity and low levels of savings and investment leading to stagnation of economic growth.

It appears from Table 5.7 that the developing world has the largest share of land resources and world human resources, 48 percent of the former and 46 percent of the latter.

Table 5·7

Land and human resources of the three worlds

Regions	Area in 000,000 km^2	% of world Area	% of world population	Population increase % per annum
Developing world	66	48·2	45·8	2·5
Developed world	36	26·3	21·8	1·2
Socialist world	35	25·5	32·4	1·5

With the present rates of growth of population in the three worlds, (is shown in Fig. 5·2) the least in the developed world (1·2 percent) and the highest in the developing world (2·5 percent), the percentage share of the world population for the developing world will go on increasing through passage of time with a simultaneous increase of pressure of man on land resources, the latter remaining constant for ever. The socialist world has about the same share of land resources as that of the developed world but one-half more human resources. Its rate of population increase is slightly higher than that of the developed world but much lower than that of the developing world. In these respects the socialist world occupies an intermediate position between the other two worlds Fig. 5·3 shows that the developed countries of Europe, Japan and socialist countries in Eastern Europe have the lowest rate of increase of population, much below the world average, 1·9 percent per annum.

The US and the USSR on the other hand, have their population growth sightly at a higher rate. A few developing countries in Asia, Africa and Latin America also have the rate of increase of their population around the world average, This in case of Argentina may be due to a higher national income which may not fall for short of that of a developed country. Others like Saudi Arabia and Chand do not afford enough opportunities for people to multiply. Among the developed countries, Canada, Australia and New Zealand have a higher

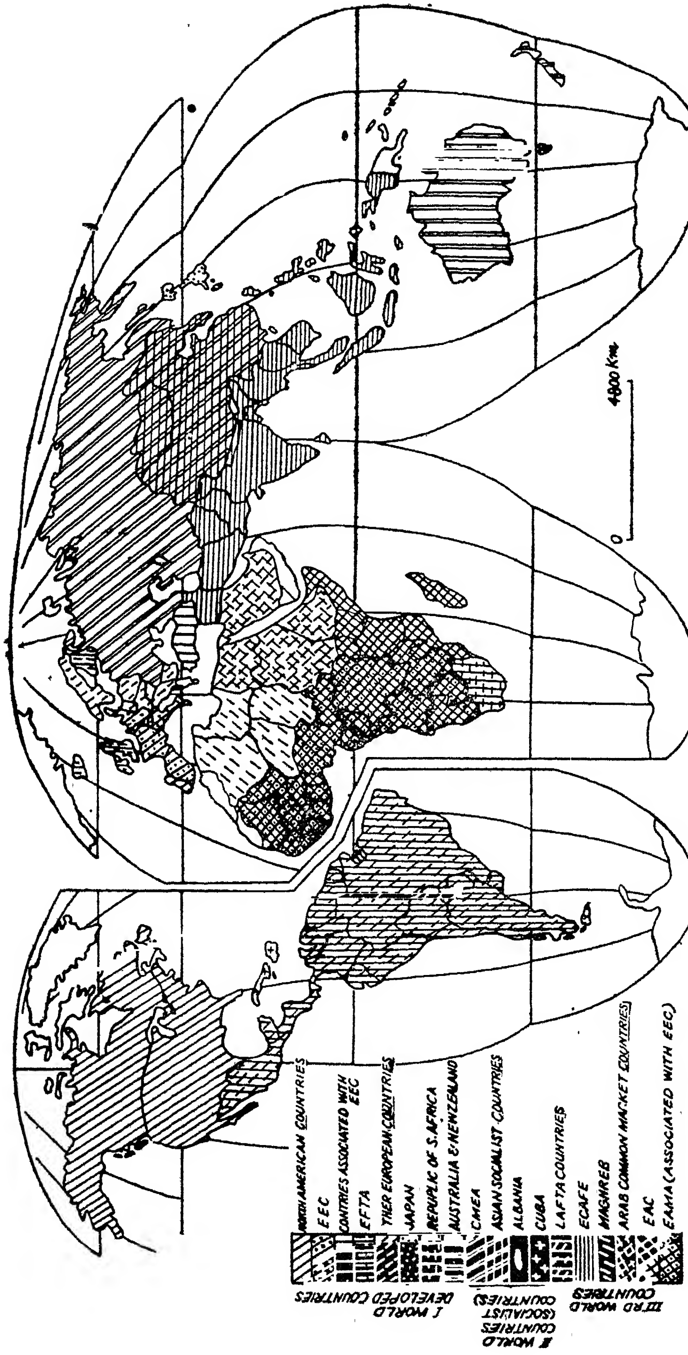

Fig. 5·3. Three Worlds

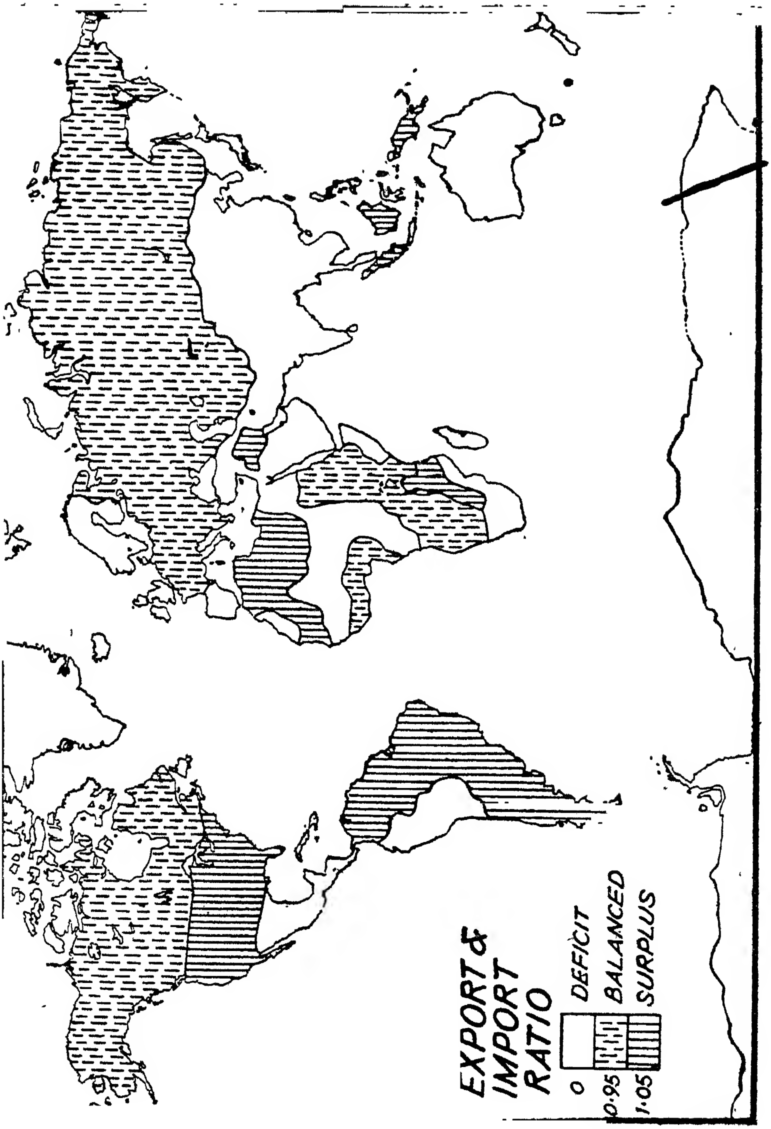

Fig. 5 4. Exports and Imports Ratio

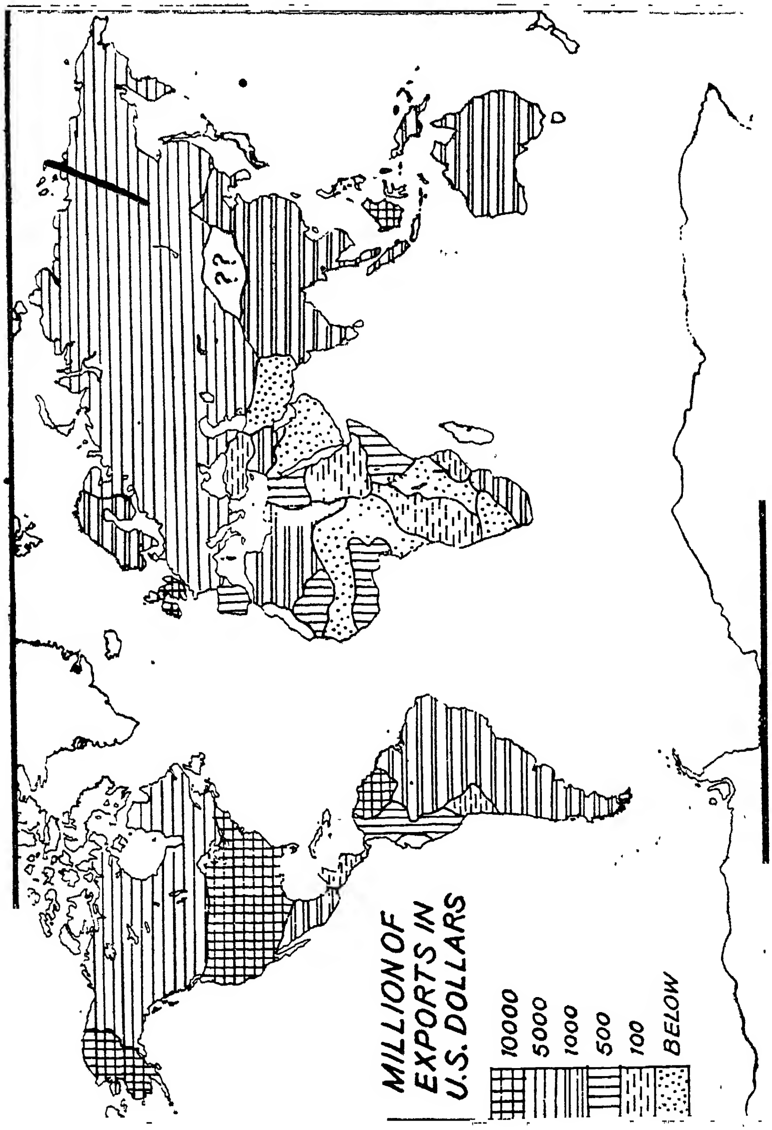

Fig. 5·5. Value of Exports in U.S. Dollars

rate of population growth than that of world average because these countries are very thinly populated compared to their potential natural resources.

The greater part of Latin America has the highest rate of population increase, more than 2·7 percent per annum with 26·8 percent available land resource for human use, which is shared by many other countries in eastern Africa and western and south-eastern Asia. India and Indonesia form a separate group having the rate of increase slightly lower than that of Latin American countries but in relation to their enormous base the absolute increase of population becomes staggering.

The developing world contains more than one-half of the worlds arable land resources and agricultural population and derives about one-third of its income from agriculture, its share in world export trade is a little more than a quarter of that of the developed world. This means a very small earning in foreign exchange which accounts for the slow growth of manufacturing and consequently the smallest value added to industry, less than one sixteenth of the total world value. Figure 5·4 shows that in terms of actual value of exports, the U.S. and three of the western European countries: the United Kingdon, France and Federal Republic of Germany earned the most. The United States had surplus while France and Federal Republic of Germany had balanced economy so far import trade was concerned. Most of the other developed countries of Europe, Canada and Japan formed the second group, the value of exports of which ranged between \$5000 and \$10,000 million. The U.S.S R also belonged of this group. Most of them had neither surplus nor deficit trade balance. In the lower range came the developing countries—Mali, Niger, Chand, Central African Republic, Upper Volta, Guinea, Congo and Mauritania earned the least from their export trade. They had a very much pronounced deficit trade balance. Most of the other developing countries had also a deficit trade balance although the value of their exports was considerably higher, as shown in Fig 5·5.

Earth as a home of a man

The earth as a home of man is primarily concern to the geographer because they exert far-reaching and fundametal influence on the patterns of human activity. Earth is generally known as "Mother Earth", all over the world. The *vedic* earth mother or Prithivi was usually worshipped along with "Dyaus" and their epithets show their greatness and productivity, as well as their moral and spiritual character.

The available land resources of any country exercises a lasting effect on the economic life of man or nation. Indirectly, the available land resources affects the economic life because the production of raw material is dependent on the nature of landscapes. It directly limits the industrial progress of any country. In the

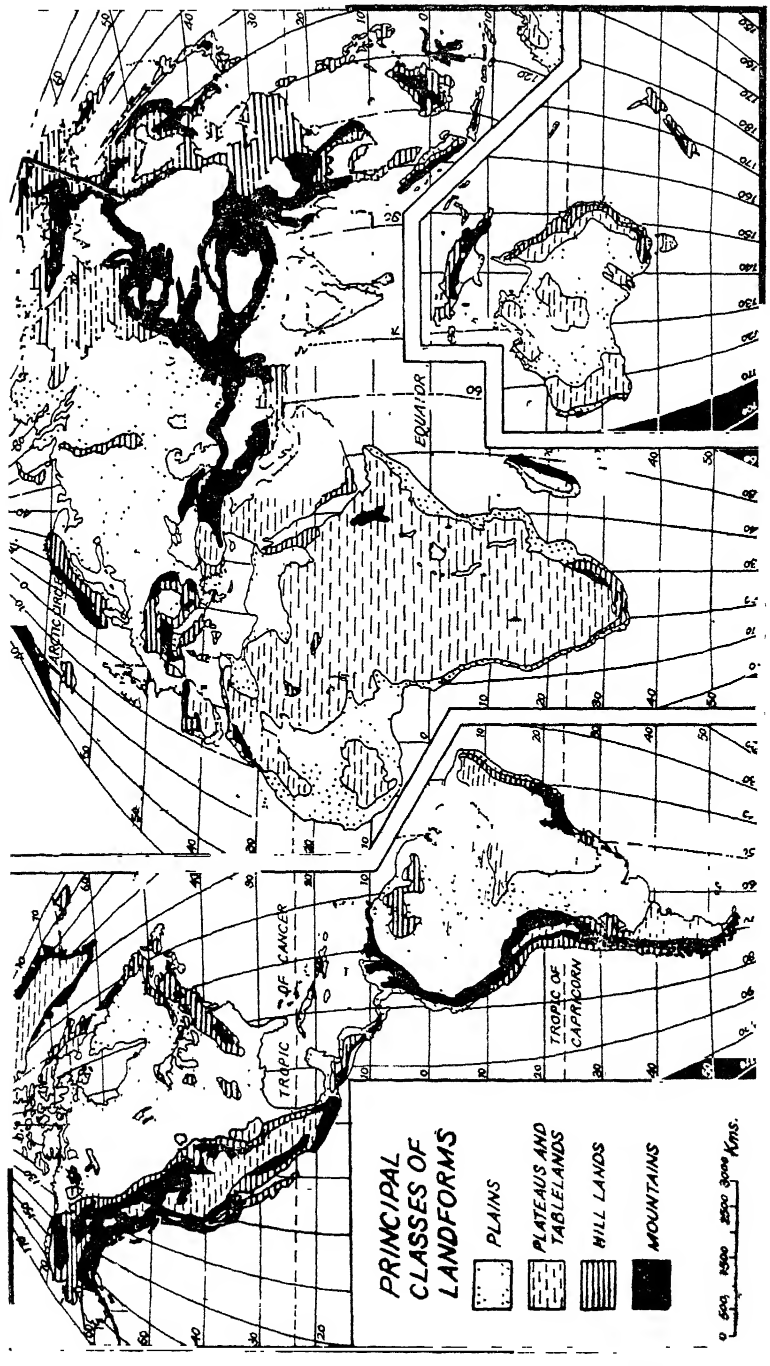

Fig. 5·6. Land Resources

hilly tracts, agriculture and industries generally do not flourish. The result is that the production of wealth in these tracts is less, and therefore, only a sparse population can be supported.

The space available to the people leaves a stamp on their industry and their psychology. Thus the relation of life to the earth's area is a fundamental question of resource geography. The amount of that area available for terrestrial life, the proportion of land and water, the reduction or enlargement of the available surface by the operation of great cosmic forces, all enter into this problem, which changes from one geological period to another.

Major Land resources

All the land resources can be generally grouped into four major types. These are :

Mountains
Plains
Plateau
Hill lands

These major land resources of the world is shown in Fig. 5·6. Plains perhaps occupy a greater area of the land resources of the earth than plateau and mountain chains together, as shown in the following table 5 8 taken from "*The world Hunger*", written by Frank Pearson and Floyd.

Table 5·8
Distribution of Major Land resources (in percentage)

	Mountains	Hills	Plateau	Plains	Percentage
Asia	20	24	24	32	100
Europe	4	21	8	67	10)
Africa	3	1	71	25	1ᒪ0
N. America	13	11	24	52	100
S. America	11	9	24	56	100
Oceania	9	19	24	48	100

Ecology of Land Resources

Of the serval types of Land resources, mountains are the least hospitable to human culture The main occupations of people in mountainous tracts are grazing of domestic animals, digging minerals and lumbering. The mountain ranges are a hinderance to communication and, therefore, we do not find good means of communication in these tracts. Trade and commerce directly depend on the means of transportation and communication, which are generally absent in such regions. Mountains are source of valuable mineral products, and out of their elevation and denudation has come a large part of the habitable land of the earth.

Land resources are the real source of mineral resources. Throughout the world there is a close relation between mountains

and some sorts of mineral resources. Some kinds of valuable mineral may be found away from mountain such as coal, clays and certain building stones, but with few exceptions, the great mining regions of the world are in mountain areas, the chief exception being certain of the deposits of coal.

The United States, equally with Germany, shows the relationship of mining to mountains. Iron, coal, petroleum and lesser qualities of other mineral products are found in the Appalachian mountains and the Adirondacks. The worn-down mountains about the western end of Lake Superior are the seat of the most important iron mining industry in the world, and one of the leading copper deposits. In the Deccan plateau, which rank high among the great mining regions of India, are produced the bulk of our gold, silver and copper, besides lead, zinc and other metals.

Mountain scenery is an asset of mountains upon which it is impossible to place a direct money value. Attracted by the fresh air, by the grand scenery, by the invigorating climbs by the hunting and fishing by the mineral springs of medicinal properties, people resort to mountains in great number, especially in Europe and America.

One of the great sources of income to the Swiss people today is obtained from the tens of thousand of tourists who flock to the Alps each summer. Paths, roads and even railways are built to remote and inaccessible points and hotels are to be found almost anywhere that numbers choose to go. The tourist industry has led to the opening up of much of the Alpine region from France to the far end of the Tyrol, and in summer this mountain range is without doubt the most densely settled, high mountain region of the world.

In India, for example, it is only in a few sections that the asset of scenery has as yet become of importance, though one can not doubt that this is one of the future resources of many parts, as yet known only to the few.

Plains are the largest portion of the land resources of the earth. Their influence on the life of man is, therefore, very important. We find today that the largest part of the world's population lives on the plains, the biggest cities of the world are found on the plains, the most important agricultural regions of the earth are found in the plains, and the greatest network of the communication lines covers the plains. All this is due to the fact that most of the plains of the world offer the easiest conditions for the early progress of man.

CHAPTER 6

SOILS : AS A RESOURCE

Soil and water are the two necessary earth resources. Soil is a natural body developed by "natural forces acting on natural materials. It is usually differentiated into horizons of mineral and organic constituents of variable depth which differ from the parent material below in morphology, physical properties and constitution, chemical properties and composition and biological characteristics."

The Soil Resource

The most valuable national asset in any country is its soil. If soil is well managed, its fertility is not only renewable but improvable. If it is misused, the soil can be permanently damaged or irretrievably lost.

Soil undoubtedly is the greatest asset of a nation. When the soil is lost, prosperity and culture of a country are also lost. The nation dies. This has happened in several parts of the world. The empires of Babylon, Assyria, Persia and Carthage were destroyed by the floods and advancing deserts. The soil has shaped the destiny of the nations in the past and shaped their culture and outlook. In the words of Earl Portsmouth, "I can not believe that the golden age is a myth of superstition or a figment of idealists. I believe it to be a race memory, well-nigh universal of times when various peoples have achieved a way of life in harmony with nature, when they possessed the secret of partnership with the soil that health, gentleness, beauty and strength were the rule. The memory was nearer to the Egyptians, Indians, Greeks and Aztecs than to ourselves." The ancient ruined and advanced civilizations of the world is the product of the soil. In the words of Wilcox "The history of civilization is the history of the soil and the education of the individual begins from the soil."

Whether transported or residual in origin, the soil as the seat of plant growth is of vital ecological interest to man, for it contains mineral substances which he needs, and the plants have developed the power of abstracting these from the soil and transforming them to a condition in which they can be incorporate into the human body.

A country, in order to feed its population, and to provide raw materials to meet its other requirements has to depend mainly on its soil resources and agricultural productions. Just as human beings and animals have certain requirements for their well-beings, plants also have their requirements which are met out from the soil. Of course, many ecological factors are involved in proper utilization of the soil resources to produce the best plant growth.

It can not be denied that land, no matter where and how it is situated is a valuable national asset, as previously stated, if used wisely, and is capable of meeting one or the other vital requirement of human beings. Food is by no means the only need, there are other equally vital needs, for example, fuel and timber. Therefore, if the land is properly used, there is no need for even one metre of land to remain idle-contrary to the existing state of affairs where there are hectares of hilly, broken, ravines and sand dunes which are utterly barren and are not contributing anything to the wealth or welfare of the nation.

Therefore, soil is a natural medium for plant growth. Soil supplies nutrients for growing plants, and plants manufacture food for animals and food and fibre for man.

Soil is the fundamental raw material of agriculture and the important soil conditions favouring crop production are associated with—(a) satisfactory drainage, (b) depth and tilth, (c) presence of adequate supplies of suitable plant food materials, (d) absence of injurious substances or pests. All these soil as well as climatic conditions can be regarded as ecological factors for agriculture.

Since water is often the chief limiting factor, even in humid regions, for crop production, every effort should be made to increase and conserve the supply of available soil water cultural and tillage practices that increase water absorption reduce surface runoff; moreover, these same tillage practices control weeds thus eliminating useless transpiration.

Man's use of land is not static, but is subject to change-by man and by nature. Farming that depletes mineral nutrients and causes soil erosion may made agricultural ground worthless ; the deposition of salts from irrigation waters may leave soils unproductive. Conversely, new technologies may make poor land productive. It was no mere accident that some of the oldest civilizations of antiquity had their origin in fertile river soils. In such fertile river valleys as those of the Nile, Euphrates and Indus, natural barriers of the desert and thin pasture gave some protection against invaders. Here man found rich alluvial soil annually watered by the overflow of the river and refertilized by the deposition of silt. Here man made the first large scale conquest of nature.

Ecological Importance of Soil to Human life

The ecological impacts of soil on human life is as follows :

Soil is a priceless resource from which we obtain our food, clothing and other necessities of life. It is the basis of our economic stability and the source of our national strength. With a fast growing population and a rapidly expanding economy, constantly increasing demands are continuing to be made upon the land. According to Anderson, "the soil is and remains the mysterious source of all life on land, the end and the beginning of every cycle, the unbreakable link between the inorganic world and the organic, binding man to the earth with a force as inescapable as the force

of gravity. In man's relations to the soil are epitomised all his relations to his physical environment, and the soil is, more than any other single feature of the earth on which we live, the direct concern of the biogeographer." Continues Anderson, "as our bodies came from the soil, so when we die they should return to it, if they are not hermetically and hygienically sealed in a lead coffin to putrefy instead of rotting cleanly down to humus and reappearing in the bodies of plants and animals."[1]

Every society has developed into its own soil, and exploited its geographic gifts, utilized its geographic location for the betterment of social organization. Society is more deeply rooted in the soil, the looser is the connection between land and people, and the looser the type of social organization. For example, the usual type of tribal ownership was presented by the Gaddis, nomadic herds who occupied the grassy slope of Dhola Dhar range in Himalaya west. They held their territory and the game upon it as the common property of the tribe, and jealously guarded the integrity of their land frontiers. The chief Naga tribes, who occupied the territory between the Tuzu River and Barail ranges, had each its separate domain, within which it shifted its villages every few years but its size depended upon the power of the tribe to repel encroachment upon its hunting grounds. Relying mainly on the chase and hunting, on *jhuming* or shifting agriculture, for their subsistence, their relations to their soil were superficial and transitory their tribal organization in a high degree unstable.

Student of Indian ecology generally agree that most of the Indian tribes east of Brahamputra were occupying definite areas during eighteenth century, and were to be considerable extent sedentory and agriculturalists. Though nomadic within the tribal territory, as they moved with the season in pursuit of game, they returned to their villages, which were shifted only at relatively long intervals.

Many ecological relation's exist between man and the soil of his region. These are apparent in some of the minor phases of man's life, in his great engineering works, and in certain direct occupational adjustments.

Pottery making is a very old art. Clay is dug from open pits or shallow beds reached by shaft and tunnel. Based upon clay as a raw material are the brick, tile, pottery, porcelain, and terra cotta industries. In recent years, people have begun using more of China wares and there is a good scope for this industry to be run on large scale and scientific lines. Nearness of good clay, cheap coal, or fuel supply and the facility for transportation determine the location of this industry. Such activities are found in the vicinity of nearly every large city and in addition, are scattered through all densely populated regions. High grade pottery-making districts almost invariably develop upon deposits of fine kaolinic clays. Examples of important places noted for

1. Op. cit. p. 122.

fine pottery wares are Shantung south-western England, Saxony, Bavaria and New Jersey.

In India, the pottery industry centres are located in Calcutta, Raniganj, Gwalior etc. In some states of India good China clay is found in abundance and this is why many big pottery works have been started there. There are three important centres of this industry. Firstly, the industrial zone of Calcutta which is by far the most important centre as regards pottery works in India. The Calcutta works use China clay which occurs in Santhal Pargana and Bhagalpur districts. One can see in Calcutta proper and in all the sub-urban centres, numerous pottery works producing bricks, articles for domestic purposes, insulators, hospital requisites, laboratory porcelain accessories, tea cups and plates, sauces, inkpots and dolls etc.

The second important centre is that of Raniganj and Jharia coal field. These works have been started here because of the advantage of cheap coal. Good clay is also found in Raniganj and some districts of Bihar.

The third important centre is that of Gwalior where many works have been started. The Gwalior pottery works use the clay found in the state mostly from Jabbalpore. Besides these important centres of industry, where better type of it is found, there are other places which possess local materials particularly deposits of clay and sand which are used in manufacturing water vessels and other earthern pots, as for example, Cuttack, Aligarh, Khurja, Chunar, Agra and Mangalore etc. Some of these centres have attained a very high reputation for toys, and other articles of domestic use.

The Formation of Soil

Among the results of weathering the formation of soil is to be classed as by far the most important from the human standpoint, for it is this softening and preparation of solid rock that makes possible the varied and extensive development of life on the lands. The soil, together with the underlying subsoil, is the most extensive and widespread of all the deposits directly due to weathering.

Factors of Soil Formation

Dokuchayev (1846—1903) is credited with the idea of a soil as a constantly changing function of five major soil-forming factors. These are—(1) Parent materials or mother rocks (2) local climate, (3) plant and animal organisms, especially of the lower order, (4) relief and elevation, lastly (5) age of the country or geological time.

A soil is a natural complex of mineral and organic substances suited to the growth of plants. It was not created in the beginning exactly as it is now but rather is the product of development, or evolution. It is evolved from a parent material, which generally is the mantle rock, or regolith. Over much of the land surface this mantle of rock debris has been derived directly from the decay and disintegration of the rock on which it rests ; but over

large areas it has been transported by wind, streams, glaciers or other means from a place of origin to its present place of rest. This layer of rock waste, mantling a large part of the land surface, may be but a few centimetres thick, or it may be scores or even hundreds of metre thick.

The upper portion of the regolith in which the vegetation grows, is called the soil, a loose mixture of rock fragments prevailingly of small size, ordinarily somewhat porous, and with a greater or less admixture of plant fragments. In some swampy places the soil is mainly of organic origin, but such soil is of a different origin from that which is now being considered. There is much difference in the texture of the soil, which varies from compact clay to sand and gravel, in porosity, which ranges from almost impervious clay to loose sand and gravel, in colour, which may be black, brown, red or yellow, in thickness, which may vary from one centimetre to metre, and in mineral and chemical composition. According to these variations the adaptability of the soil to cultivation varies greatly. Some soils are very fertile and the seat of thriving agricultural industries, which others are thin or seterile and quite unsuited to agriculture.

The soil grades downward into the subsoil, which closely resembles and is of the same origin as the soil ; but it lies below the zone of plant growth and contains little or no admixture of organic matter. The subsoil, in turn, grades into the underlying rock from which it is derived, where the mantle rock has been formed by disintegration of the bed-rock ; or, if transported, the sub-

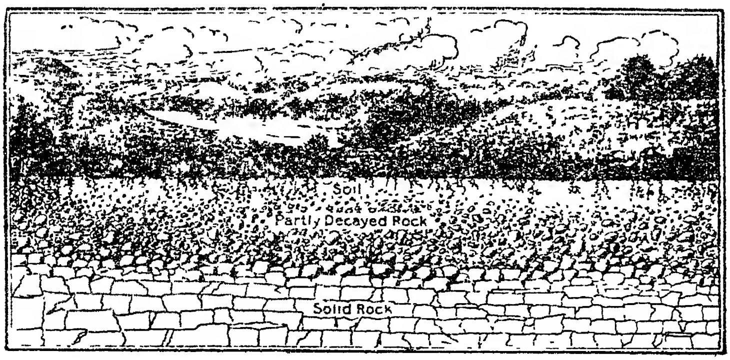

Fig 6 1. Development of Soil

soil rests directly upon the rock upon which it was deposited. Everywhere beneath the mantle of soil lie the rocks of the earth's crust, in some places sedimentary, in others igneous or metamorphic. This is clearly shown in Fig. 6·1.

The soil proper is only the upper portion of the disintegrated rock, in which there is an appreciable admixture of organic matter. It varies in depth from a few centimetres to a metre. The soil

grades downward into the subsoil, which is ordinarily less comminuted, and in which there is little or no organic matter. The depth of the subsoil varies greatly, but in regions where it is derived by rock disintegration it is not commonly more than a score or two of metre in depth, and often much less. It grades imperceptibly into the rock bed from which it is derived, and the line of division between subsoil and bed rock is ordinarily difficult to draw and very irregular; for the zone of decay extends deeper in some places than in others.

At and near the bed-rock surface, unconsumed remnants of the decaying rock exist as rounded boulders embedded in the disintegrated material. All rocks being subject to disintegration, the formation of residual soil can result from the action of weathering upon and kind of rock ; and since rocks vary in mineral composition the resulting soil naturally varies both in texture and composition, according to the kind of rock from which it is derived. In the soil itself, that is, the upper layer of mantle rock, these differences in texture and composition tend to disappear under the continued communication to which they are subjected by the action of plants, animals and percolating water. The soils of different origins still further tend toward uniformity by reason of the admixture of organic materials, which commonly amounts to six or eight percent of the whole, and in places to far more, notably in swampy areas. Yet there are notable differences among residual soils, some being coarse, others finer, in texture, some sterile, other fertile. For instance, the Black cotton region of Peninsular India the soil derived from volcanoes containing phosphatic shells is so fertile as to give the basis for a special agriculture industry, whereas round about it are areas of infertile soil derived from other rocks and hence sparsely settled and of little agricultural value.

The effect of the rock as well as of the climate on soils in general is clear. At first the parent material, on weathering, produces a distinct kind of soil, but as time goes on, the distinction between soils derived from different parent materials situated in a climatic zone gradually disappears. Relief also plays an important part in controlling the effect of climate in soil formation by influencing the air-water regime in the soil. The ability of soils to hold capillary water is determined by their porosity and absorptive power. As the particles become smaller, or the organic content higher, or the structure more granular, the capillary capacity increases due chiefly, to the influence of clay or humus colloids, and/or more effective surface exposed. The moisture content of soils, at any particular time, represents the balance between additions and removals of water. Natural precipitation, the main source of soil water, is supplemented in Panjab and western Uttar Pradesh by irrigation and at times by water brought up from deeper soil layers by capillarity ; this process is generally too slow to be of real significance in supplying the water needs of plants. Removals of water from soils result through evaporation at or near

the soil surface, transpiration from plant surfaces, percolation downward due to influence of gravity and surface runoff. Loses by runoff decreases the potential supply of soil water.

Climate functions as an independent factor in the development of the weathering complex and of soil profiles at group level. Climate influences soil formation both directly and indirectly. One of its most important effect is its influence on the movement of water in the soil through parcolation, leaching, runoff etc. It is largely this direct effect of climate which is responsible for the development of the soil. Indirectly it influences soil formation through the activities of plant and animal life. Climate also affects the development of the soil through its seasonal variations in temperature and rainfall. With decreasing rainfall outside the humid temperate areas of the earth, chemical weathering becomes less intense and the colloidal clay tends to be coarse, retaining more of its basic ions, including magnesium and potassium, at the expense of the base exchange capacity, which is low. The soluble bases released by weathering are not leached from the soil and the soil reaction consequently becomes more and more alkaline. Chemical fertility is high but lack of moisture may limit crop yields.

The Tropical climates have a mean annual temperature of not less than 12°C., with an annual range as a rule not much over 0°C. As a result there is no cold season but a period that is comparatively cool. Rainfall is seasonal and very variable in amount. As one passes to subtropical and tropical regions of high temperature and high rainfall with intensified weathering and leaching, the silicate minerals are more completely decomposed, bases and silica are leached away and the resulting soils, known as laterite, contain high concentrations of iron and aluminium. They are low in exchange capacity, low in present and potential fertility and, since bacterial activity is high throughout the year, organic matter is so rapidly destroyed that its content is low in spite of its rapid production by vigorous growth of vegetation.

Polar and cold humid zones have a continuously low temperature, except for a very short summer. The mean of the warmest month is under 10°C, and that of the long winter well below 0°C. In Antarctic regions the annual summer mean is below–5°C. Precipitation is about 254 mm. a year. In the cold to cool humid regions, forest vegetation, mainly coniferous, combines with the climatic conditions to produce the typical podsol soil group. From the chemical point of view it is found that the decaying needles of the forest floor produce a highly acid leaching solution which not only removes the basic ions excessively, but also dissolves iron and leaches it downward. where, with some of the aluminium and dissolved organic matter, it is redeposited in a tight layer some one and half metre below the surface. The soil layer immediately above this deposition is bleached white and ashy. Climate, aided by vegetation with it fosters, acts upon the parent material. The action of these two factors is conditioned

by local relief or topography. Each climate together with its vegetation and other biological activities that promotes, imparts its own special characteristics to the soil, no matter what the original parent material may have been.

The length of time during which these factors are operative further influences the character of the ultimate product. The factors are thus inter-dependent, each modifying the influences of the other. The various factors involved in soil formation require time for the completion of their several processes.

Purpose of Soil Classification

The fundamental purpose of soil classification and mapping in the world is to gain a better knowledge and understanding of the origin and properties of soils and their distribution as part of the general advancement of soil utility upon which the economy and prosperity of the people ultimately depend.

The most important problem of the world today is to ensure that the people of the country will be fed. To deal with the inevitable increase in food consumption due to rising populations we must have precise knowledge about the geographical extent and location of different soils, and determine how may they best be used and, at the same time, preserved for posterity.

The Great Soil Groups

The great soil group, defined as a group of soils having a wide distribution and a number of common fundamental internal characteristics. Groups have multiplied at an alarming rate, for while Dokuchayev and Sibirtsev had twelve groups for the whole world, now, for eastern Europe alone, there are sixty groups and many subgroups. The USA has thirty-six groups, with provision for more in the tropical areas of Puerto Rico and Hawaii and in the Tundra of Alaska.[1]

Although this resource covers the land as an almost continuous blanket it differs greatly in character and in usefulness to man from region to region, from farm to farm, and even within single fields. The early attempts to classify soil were based on its products rather than on its intrinsic properties, because men in ancient times were interested in the fruits of the soil, not in the soil itself. While soil classification was dominated by geological concepts throughout most of Europe, a group, of Russain scientists led by V.V. Dokuchaiev began to study the soil itself, not as decomposed rock but as a natural substance warranting special attention. Dokuchaiev proposed the first cassification of soil resources. The language barrier between Russia and the rest of the world prevented dissemination of the Russian concept of soil for many years. The Great soil groups of the world and their development by Konstantin Dimitrievich Glinka of the Leningrad Agricultural Institute was translated into German in 1914 and thirteen years later, in 1927, into English. This work revolutionized soil resource classification

1. Soil Classification, A comprehensive System, Seventh Approximation. USDA, 1960.

throughout the world when it finally became known. Under its influence Europe soil scientists emphasized concepts of soil development in their classification systems.

Knowledge about soil resources, increased rapidly after 1930, and many schemes for classifying soil resources were proposed in different countries. The two major types of soil are residual and transported.

The residual soil derived from the disintegration of granite varies in texture, containing grains of quartz and clay side by side; and the residual from the disintegration of a given thickness of granite is many times greater than that from limestone of the same thickness. Even in the case of soil produced from granite, however, there is some removal of soluble parts, so that the disintegrated product is much less in amount than the bulk of the rock from which it was derived.

Some of the rock materials thus transported finds lodgment on the land, there giving rise to soil far from the source of its origin. Such are wind-blown deposits, and river deposits on floodplains and deltas. These are transported soils, for although their component parts may have been originally derived by weathering, they owe their present position, texture, and composition largely, if not entirely, to the agent of transportation. Among transported soils some of the most important are those that have been brought to their place of deposit by glacial action. The soils of a large part of densely settled north-western and north-eastern North America are of this origin.

Transported soils differ from residual soils in having no necessary relation to the rock upon which they lie, and in resting upon this rock with an abrupt boundary instead of grading into the bed rock.

Soil Classification

Modern soil classification provides a means by which existing knowledge of soils may be arranged in a systematic way. Individual soils are fitted into various group and given names after an appraisal by inspection and examination of their profiles, *i.e.*, of the layers which make up a cross-section of the soil from the surface to the parent material. The upper horizons which are most subject to leaching and to the accumulation of organic matter are termed the A horizons, the next where deposition of leached material takes place are termed B horizons, and lower down where primary weathering occurs are the Chorizons. A hypothetical horizons are given in Fig 6·2.

The A, B and C horizons have varying characteristics in different soil resources, and it is an assessment of these characteristics which is used in placing the soil in the classification. These characteristics reflect the role of climate, vegetation, parent material, relief and drainage in this resource formation over the time of its existence and control the nutrient status and water relations of the soil resources. The soil and water relationship is given in Fig. 6·3.

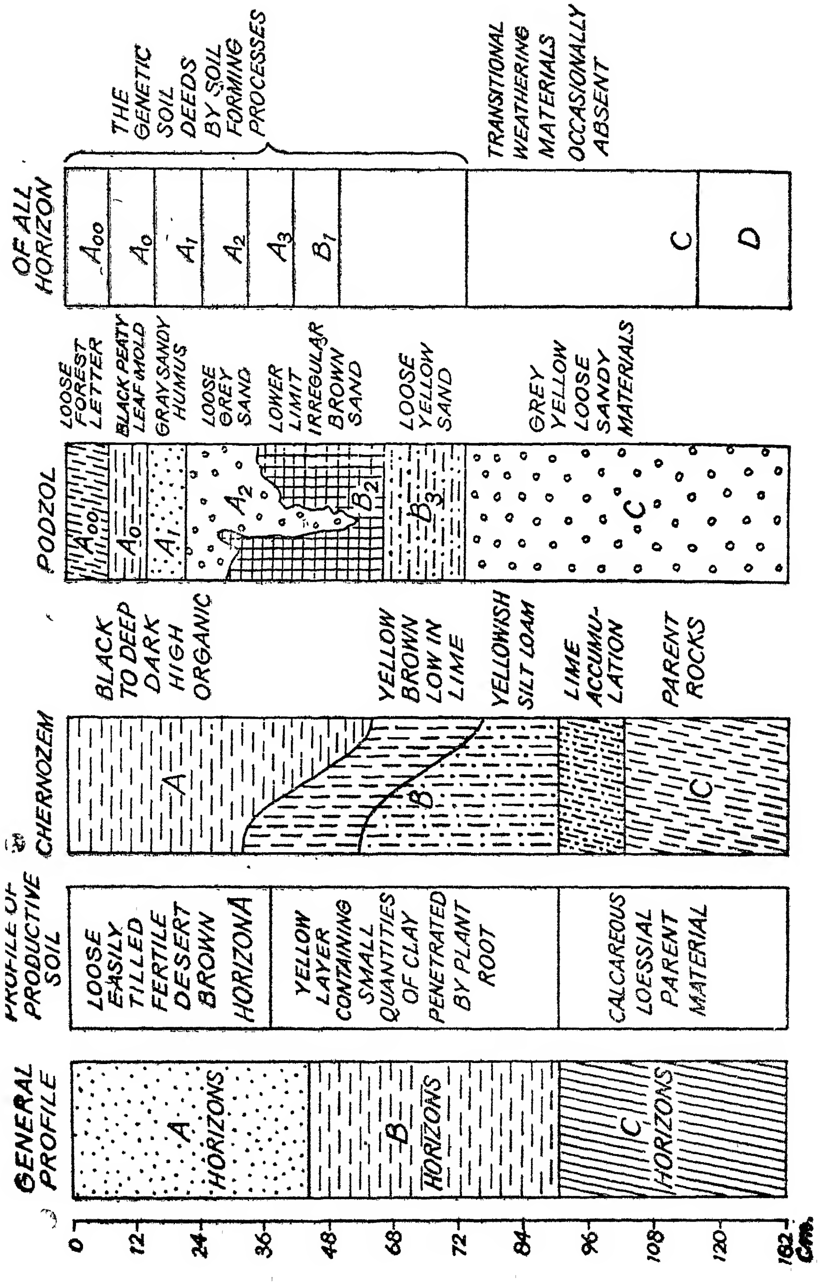

Fig. 6.2 Soil Profiles

In classifying soils the most important characterstics which are noted during an examination of a profile in the field are the :

(a) colour of each horizon,

(b) texture of each horizon,

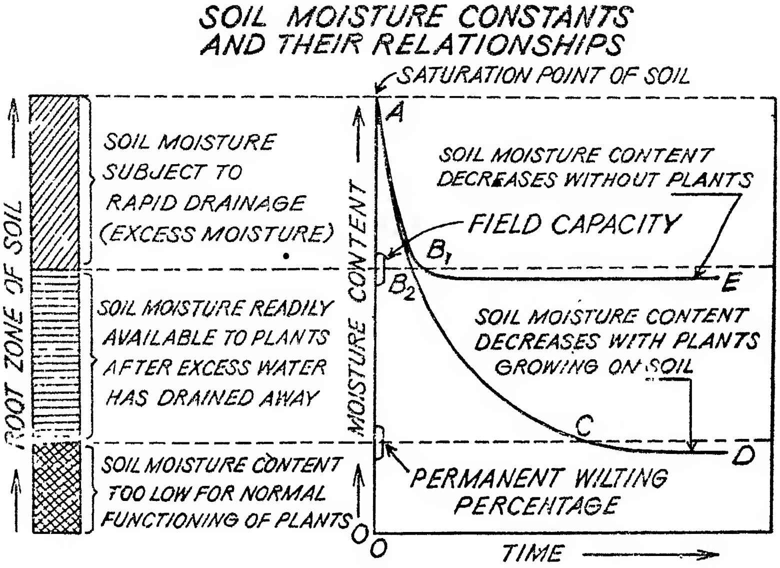

Fig. 6·3. Soil and water relation.

(c) structure of each horizon,

(d) consistence of each horizon,

(e) occurrence of lime, gypsum or soluble salts in any horizon,

(f) occurrence of ferruginous, manganiferous or siliceous concretions in any horizon,

(g) occurrence and nature of organic matter in any horizon, including plant roots and their soil fauna,

(h) thickness and arrangement of the horizons and their definition in the profile,

(i) external and internal drainage status and the presence of a water-table in the profile,

(j) nature of the parent material of the soil profile.

SOIL CLASSIFICATION OF THE WORLD

Kellogg divides the soil resources of the world into the following main classes[1] :

Tundra Soils

Tundra is generally known as cold desert of the world. For most of the year the mean monthly temperature is below freezing

1. Kellogg, C.E., Year book, U.S. Dept. Agri. 1941.

point, and winters are long and severe, the ground being covered with snow. The summers are short and warm, but even in July the mean monthly temperature does not rise above 10°C; relatively high temperatures may be reached during the daytime, but the subsoil, *i.e.* the ground about half metre below the surface, is perpetually frozen. Here, though heat is lacking, there is no deficiency of moisture despite low precipitation, and chemical weathering is weak. Site is the main influence in Tundra soil development, with impeded drainage in lowlands and incipient leaching on elevations. Thorp and Smith[1] have made an outline study of the influence of geology or soil resources of Tundra. A large part of Tundra is poorly drained and the prevailing soil conditions are those of bog and hummocky marshland. The zonal order was divided into six subdivisions according to zonal topography, geology, climate and vegetation. The six sub-divisions are known as : (1) *Polar soils* or *Subarctic soils*, including arctic brown soils, peaty, gleyed and cryogenic soils ; (2) *Podzol* or light coloured surface soils of cool temperate areas, (3) *red loams* in valley regions (4) *degraded chernozem*—soils of transitional zones, (5) *the dark coloured* soils—especially in grassland areas and (6) *light coloured* soils—They are best developed on uplands in the Tundra.

Podzol Soils

Podzols are the typical mature soils of regions having humid Subarctic climate. This soil which is characteristic of regions having a sub-polar climate, and one which therefore develops mainly under a natural vegetation of Taiga or coniferous forests. It develops, in fact, where the precipitation is considerable but evaporation limited ; the upper layers are leached, and the soil has a characteristic greyish-white colour. On the whole, the Podzols make poor agricultural soils. Huge areas of the coniferous forest regions of northern Canada and the northern U.S.S.R. are covered with podzols. Fig. 6·4 shows the areas of Podzol soils of the world.

Grey-Brown Forest Soils

Grey-brown soils occur in the mid-continental area of Canada in northern Saskatchewan and Alberta, northern Spain to Ural, in north-eastern People's Republic of China to Korea, Honshu and Cape lands of South Africa. They are found on base-rich parent materials in association with podzols on sands, gleys and peats. On this basis this is also known podzolic in character. Of the available parent materials in central and lowland west Europe, most are on relatively young geomorphic surfaces, and parent materials vary from acid sands through calcareous loams to clays of various kinds, the clays situated on high lying sites, not necessarily in depressions, where, of course, gleys would result. The grey brown soils have generally better structures than the other forest-land soils, keep their structures better under cultivation, and

1. Throp, J., Smith G.D.—Soil Science (U.S.A.) 67, 1949, pp. 117–26.

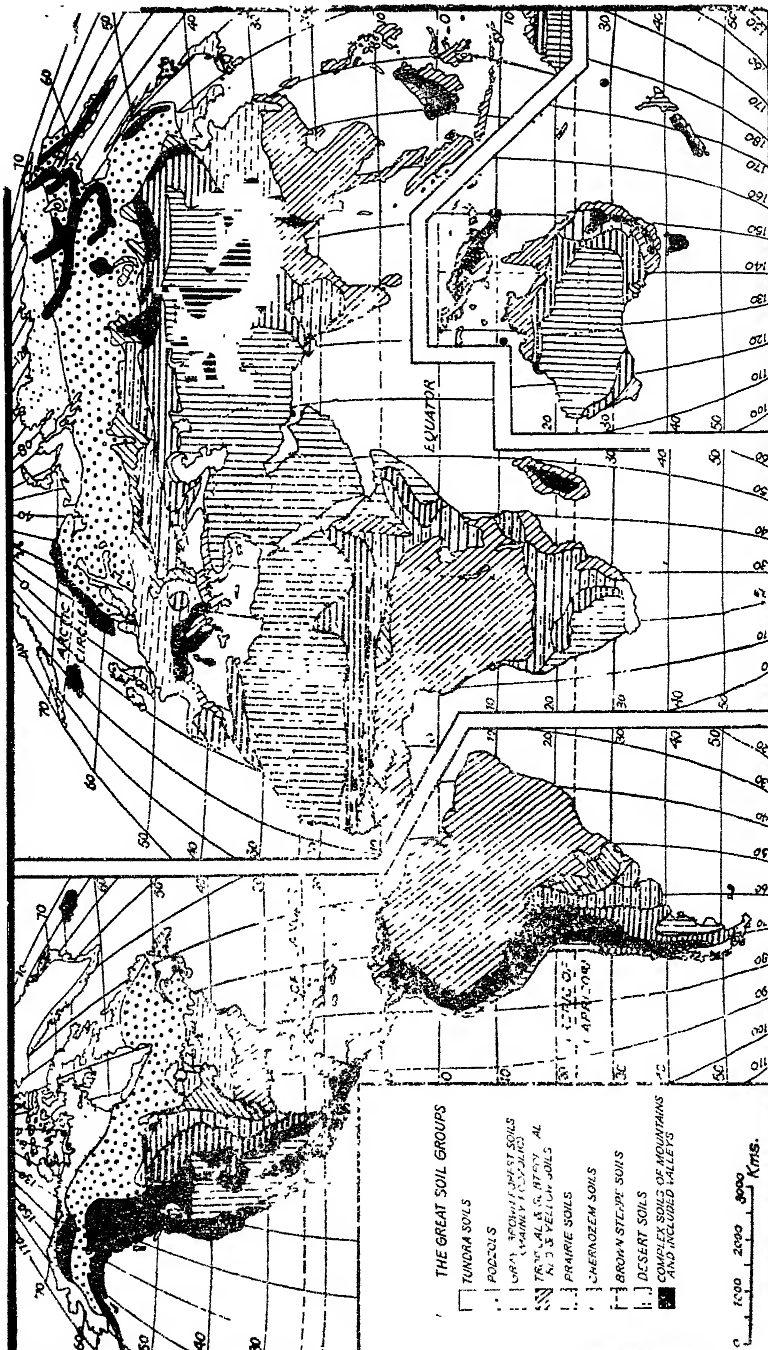

Fig. 6·4. Soil Classification

respond more readily to the application of lime and organic fertilizers.[1]

Red-yellow Soils

Somewhat apart from the soils of the Mediterranean area are the yellow-red soils of moist sub-tropical North America, Cuba, Central and Tropical and sub-tropical regions of South America, the Abkhaz littoral of the eastern Black sea in western Georgia, presumably extending into the northern Turkish coastlands, South central Africa and most of Monsoon Asian countries and North Eastern and South eastern Australia.

The red yellow soils of South east USA are deeply weathered, shallowly-podzolized soils, often much eroded. They occur on many different parent materials and geomorphic sites. They are usually well drained, and are acid, devoid of free lime, and have thin phosfatic and magnesium layers. The South American soils are very similar to those of Central African and monsoon Asiatic soils, for both podzolization and laterization are active in the soil and in the weathering crust respectively. The peninsular region of India with its crystalline rocks, and the Chota Nagpur with, its hard pre Carboniferous rocks show red podzolic soils. Some broad high level peneplains have yellow soils, and the coast plain is also dominated by hydrated yellow soils.

Red and yellow podzolics have higher contents of aluminium and iron than northern podzolized soils, but much less iron (Fe) than true tropical ferrallitic soils. Aluminium is present in silicate rather than hydroxide form, though silicate minerals mainly occur at depth.[2] Several parts of the world have similar quasi-monsonal climates and red and yellow podzolic soils. In their cooler parts, with some winter rainfall, the degree of surface podzolization increases, while in their warmer, equatorward,parts, ferrallitic tendencies are more marked, especially or well drained sites.

Prairie Soils

Prairie soil has a restricted meaning in soil science, relating to complete decarbonation without movement of sesquioxides. Most grassland soils of Central North America and Eurasia, Africa and South America are cultivated and are prairie soils. In north America prairie soils occupy much of Iowa, upland Illinois, eastern Kansas, Oklahoma and Texas. Physically, they have blackish, deep, mineral organic on upper portion ; thin, dark brown in middle with clay accumulation ; and. calcareous subsoils. They are mainly base—saturated and salt free ; move so in the humid eastern or northern parts where the carbonatic layers lie deepest. Reddish prairie are highly productive of both crops and grass ; the upper horizons are slightly acid, granular, clay loams, humus-rich, and grey brown ; the middle are reddish granular clays and the lower, red or yellowish brown blocky horizons with shot like iron Fe and man-

1. Finch, V.C., Trewartha, G.T —Elements of Geog pp. 460-461
2. Report of all-India Soil Survey Scheme, Ind. Agri Res. Bull. 73, 1953.

ganese. High lime content encouraged an original vegetation of tall prairie grasses rather than forest. In several humid regions there is another kind of dark-coloured soil, high in humus, which is found in association with the red and yellow soils, the grey-brown forest soils, and perhaps others. It is similar to prairie soil in character.[1]

Chernozem Soils

Chernozem (a Russian word meaning black earth) is the name applied to a type of soil that is naturally the most fertile, although perhaps not the most adaptable, of the grassland-soil group. Chernozem is very productive soil, black or dark brown in colour, covering an extensive area of the southern U.S.S.R., north of the Black sea, and part of Hungary and Rumania, consisting of *Loess* mixed with a large proportion of humus and some lime.

The black earths of the U.S.S.R., largely in the Ukraine, from much of the country's richest agricultural land. The soil is so rich in plant foods that it will take crops for long periods without the addition of fertilizers, and has no superior for production of cereals, etc.

A similar soil also covers a belt of land extending from Saskatchewan, in Canada, through N. Dakota to Texas, in the U.S.A. It is associated with a natural cover of grass. In Canada, Chernozem occur in S. Manitoba, in central Saskatchewan and in Alberta, as far north as the Peace River at 57° N.

In Eurasia chernozem are widespread. The westermost area of modal chernozem is South of wroclaw, but degraded chernozem occur as far west as Braunschweig. South-east Europe has more typical chernozemic soils—in western Czechoslovakia; Central Hungary, North Bulgaria and South Rumania. It is often known as lava or regur soil or trap soil in India.

The chernozem soils are further subdivided into[2] :—

1. **Degraded Chernozem**—Chernozems in central Europe are degraded with reddish in middle horizon and are located on loess or-late Tertiary marls, as in the Vienna basin. The brownish chern ozem of northern Balkans is transitional to the meridional brown earth, the degraded Russian forms to the grey forest soil.

2. **Typical Charnozem**—This soil varying in humus content from 50% in Ukraine to 10% in Trans-Volga. This soil is mostly developed in Eurasia.

3. **Ordinary Chernozem**—This type of soil is mostly confined in Russian Khirghizstan and north Kazakh. Humus contents vary from 5% to 10%.

4. **Southern Chernozem**—The southern chernozem soils reach their most excellent development in the middle latitudes, especially on the gently undulating uplands along the prairie-steppe margin of the U.S.S.R.

1. Finch and Trewartha, op. cit. p. 464.
2. Kononova, M.M., Soil Organic Matter, p. 361—4, 1961.

5. Carbonate Chernozems—Carbonate chernozems are marked by areas where there is dense vegetation. This type of soil is mostly confined in warm, moist Azov-Cis-Caucasian area of Russia.

6. Compact Chernozem—These soils are highly retentive of moisture and extremely compact. These have little decarbonation because of their high content of physical clay. They are rich in iron, lime and alumina. Compact chernozem have high contents of organic matter and are rich in humus.

Brown Steppe Soils

The brown steppe soils of Eurasia are mainly found from Caucasus mountain to Lake Bakal. They are found on base-rich parent materials in association with podzols on sands, peats and gleys. Brown steppe soils occur in the mid-continental area of Canada and U.S.A. from Alberta to Texas. Brown steppe soils also occur in north eastern Australia the north-west of the desert soil and are long cultivated, resembling the Pampas of South America, while in western Australia, they show more clearly the long continued effect of invasion of sandy soils by Karri (Eucalyptus diversi colour) and Jarrah (E. marginta), and have only recently been widely cultivated. These soils are also found in Sudan and union of S. Africa. This area is a continuous sod cover of various species of short grass, but it also includes areas of grass with intermingled desert shrub. The roots of the grasses provide an abundant but less penetrating source of humus than those of the tall grasses. The dryness of the earth has promoted the formation of brown rather than black humus, which is intermingled with a powdery surface soil and lies above a subsoil of somewhat coarser and more lumpy structure than that of the chernozems.

Desert Soils

The typical soils of the arid lands of the middle latitudes generally called the grey desert soils. The soils of deserts also vary. Valleys in the Sahara desert have alluvial and saline soils of varying texture, mesas have sandy mixed soils, pediments have cemented gravelly or coarse sandy soils of a colluvial nature, with pH 8·5, and stony pavements are common, the combined result of upward movement of stones and of deflation. Alkali and saline soils are widely distributed in the drier areas of the world. In regions of low rainfall, salts accumulate where drainage is poor, their origin being caused by insufficiency of percolating moisture to wash out and carry away in the drainage the soluble salts present in the parent soil material or those that are formed by its weathering. In some areas the surface accumulation of salt and alkali is so great that cultivated plants cannot grow in it.

Complex Mountain Soils

The complex mountain soils are characteristic of rocks in which large quantities of iron are present. These soils are, therefore common in Meso-Tertiary mountain belt of the world. These soils are highly porous and are fertile only where they are deep and

finely grained. They are generally poor in nitrogen, phosphorous and humus. They are poor also in lime.

SOIL FERTILITY

Soil fertility may be defind as the ability of the soil to provide all the essential plant nutrients in available form and in a suitable ecological balance. The continued prosperity and well being of the people of any nation is dependent upon several factors, one of the most important being the level of soil fertility.

The soil must always be kept in a fertile condition if high yields are to be produced and people are to prosper. If any essential nutrient is deficient it should be supplied, since any deficient nutrients limits crop yields. Higher and higher crop yields are essential for the feeding of an increasing population. The soil fertility, therefore, should not only be maintained but constantly improved to reap rich harvests.

Soil productivity is the capacity of a soil, in its normal climatic environment, for producing a specified plant, or sequence of plants, under a specified system of management. The qualifications are necessary, for no soil can produce all plants with equal success, nor can a particular system of management produce the same results on all soils. In resource geography, the economic aspects of crop production, which may have far-reaching social effects, are readily influenced by the character of the management systems. It is appropriate, therefore, in discussing soil resources productivity, to present the subject in terms of its relation to management.

Broadly speaking, management affects the productivity of soil resources into two ways—(1) by increasing the efficiency of the soil resource in meeting crop requirements and (2) by protecting the soil from deteriorating influences such as (a) the removal of plant growth (b) losses through drainage and (c) erosion from wind and water. To serve these purposes effectively, management systems must be devised to fit both the soil and the type of farming to be followed. Such systems involve a consideration of three groups of management practices : (1) tillage, that modifies the soil resource by means of tools, (2) cropping, that affects the soil resource through the choice, sequence and disposition of crop plants; and (3) replenishment or treatment, that restore deficient constituents to the soil resource.

In practical agriculture, there is a tendency to neglect the use of the treatment practices. The omission hastens the exhaustion of soil resource, encourages erosion of soil resource and leads to decline the productivity of soil resources. When properly used, treatment practices retard or eliminate the unfavourable effects of crop production upon this resource and in addition they usually raise crop yields to higher levels.

Fig. 6·5 shows that the soils of only medium fertility are among the greatest crop yielders, while soils of high fertility are often poor producers. This does not mean that the yield of crops from

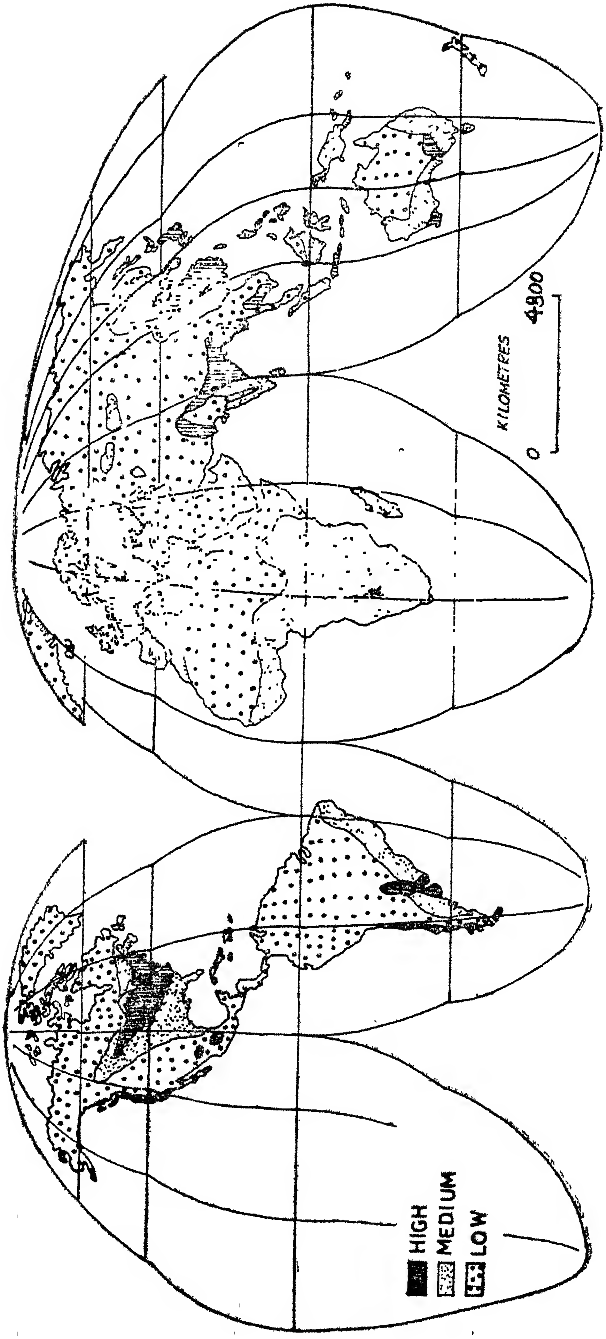

Fig 6·5. Soil Productivity

them is necessarily very high : it only means that they are suitable for crop production. High yields of crop always go with intensive farming, implying efficient manuring at suitable intervals. No soil, however fertile it may be, can show large yield without the addition of suitable manures.

It has been felt that there is an urgent need for promoting the use of green manures and nitrogenous fertilizers on a large scale in all parts of the world. Application of these, especially in conjunction with phosphatic fertilizers has been found to increase crop yields very considerably. The use of green leaves and wild leguminous plants serves very well the purpose of enriching the soil.

Soil fertility of a high order is dependent on sound cultivation practices and the use of soil conserving crops. Faulty cultivation methods and inadequate crop rotations can lead to deterioration of soil tilth on susceptible soils and ultimately to some degree of crop failure because of imperfect seed germination and inadequate intake of moisture. Such soil damage also leads to the apperance of wind and water erosion, particularly of sheet and gully erosion on sloping land.

SOIL EROSION

Meaning of Soil erosion

Soil erosion is usually described as the carrying away of soil by either wind or water. The erosion dealt with under this heading is less spectacular but much more vital importance to the welfare of mankind. It is the carrrying away by wind or water or glaciers of the soil resource from farms or fields and ranches so necessary for the raising of food. fibre and other agricultural products. Erosion of this type has been greatly speeded up by man's mismanagement of land, even to the point of destroying it for practical agricultural use within one generation. Fig. 6·6 shows the regions of various erosional processes of the world. In many parts of the world, soil erosion is a serious menace. The rapidity with which development has accurred has often led to the employment of agricultural methods conducive to erosion and, in consequence, large tracts of land in the world have already been rendered unproductive, while much larger tracts are threatened. Dr. Bennett defines soil erosion thus "The vastly accelerated process of soil removal brought about by human interference with the normal disequilibrium between soil building and soil removal is designated as soil erosion."[1] According to Gorrie the soil erosion is the "theft of the soil by natural elements and is the removal of soil particles either singly or in mass."[2]

Surveys made in different countries have shown that erosion has damaged or runied for practical use hundreds of millions of hectares of once-productive land all over the world. Induced

1. Bennett, H.H., Soil conservation, p. 94, 1939.
2. Gorrie, R.M., Soil and water conservation in Punjab, p. 1, 1946.

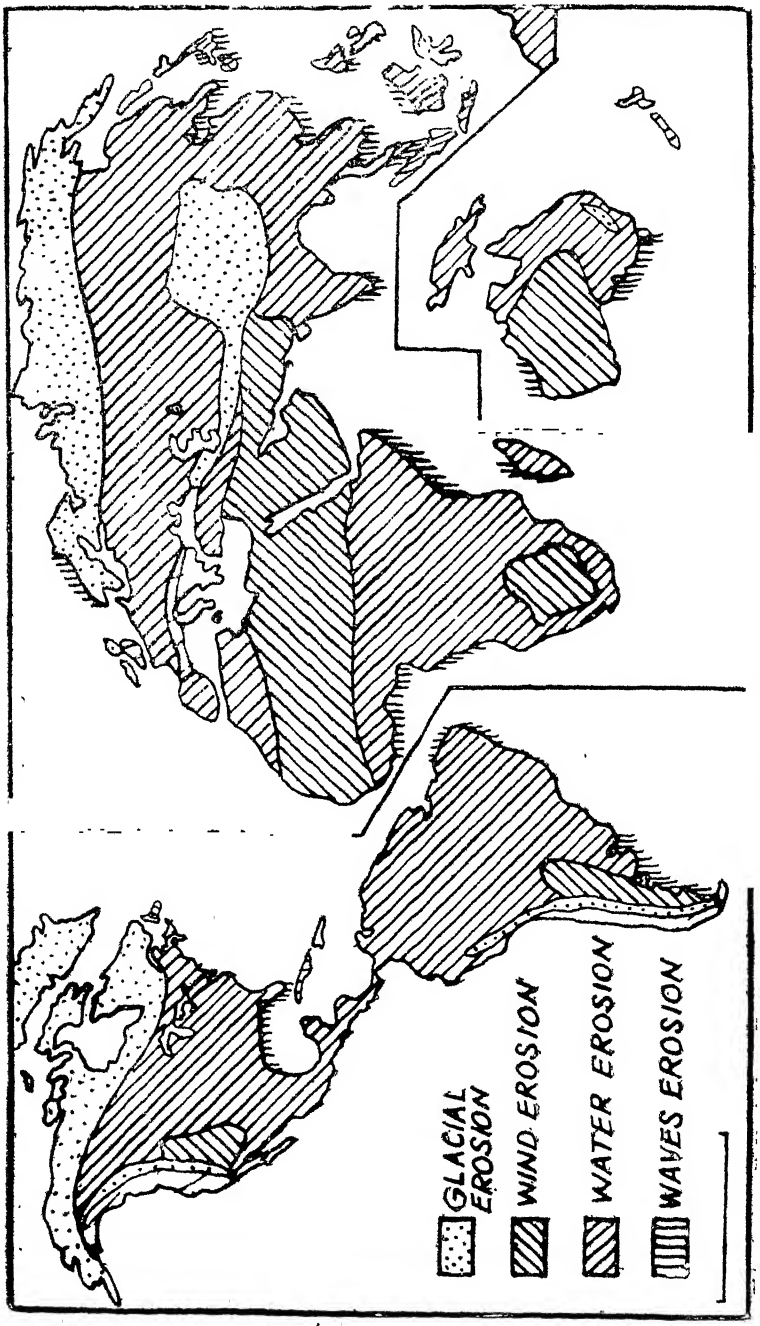

Fig. 6·6. Regions of various erosional processes

erosion continues to be a major problem in every agricultural region in the world except in north western Europe. In Great Britain and other countries of north west Europe, well distributed rainfall, lack of torrential rains and centuries of careful husbandry have preserved soil fertility remarkably well. During world war II, increase in the misuse of land changed this situation, however, and serious erosion in parts of the uplands of England, Scotland and Wales was the result of up- and down hill farming of potatoes and other row crops.

The erosion problem of this valuable resource appears to be common throughout the world. This conclusion is borne out by the Food and Agriculture Organization of the United Nations (FAO) publications.[1] After reviewing conditions in the United States and citing examples of serious and widespread erosion in China such as, "The yellow River is the muddiest great river in the world," the report continues : "But these are only examples—the problems of soil conservation are world wide. They are particularly acute in India, where, as in China, there is tremendous pressure of population on natural resources even more meager, in the Mediterranean region of Europe and the Near East, where centuries of human occupation and the nature of the climate and land forms have favoured rapid soil erosion, in Latin America, where many countries with dense populations have rapidly eroding lands, and in South Africa and Australia, where conditions and problems and the history of occupation are similar to those of plants of the United States of America." Fig. 6·7 shows the intensities of soil erosion.

In the United States Surveys show that erosion has severely damaged about 112,000,000 hactares of crop and grazing land. Another 310,000,000 hectares of crop, grazing and forest land have eroded to some extent. It was estimated, in the latter half of the 20th century, that there were left in the farms and ranches of the country about 184,000,000 hectares of land suitable for cultivated crops. This included, besides land already in crops, about 38,000,000 hac. that needed clearing, draining, irrigating or other improvements to make them suitable for cultivation. All but about 40,000,000 hac. were subject to erosion if not protected. It was found that a single dust storm in May 1934 removed 300,000,000 tons of soil from the Great Plains of U.S A. and that the soil deposited at a distance of more than 800 km. from the source of a storm in Texas, Oklahoma region contained no sands whatsoever, as compared to 92 percent of the sands in the area near the source and that it contained ten times organic matter, nine times as much nitrogen, nineteen times as much phosphoric acide, 45 percent more potash as compared to the soil left near the source of the storm."[2] Dr. Russel had estimated that the

1. FAO—Soil conservation, an International Study, 1948.
2. Bennett, H.H., op. cit. 1939.

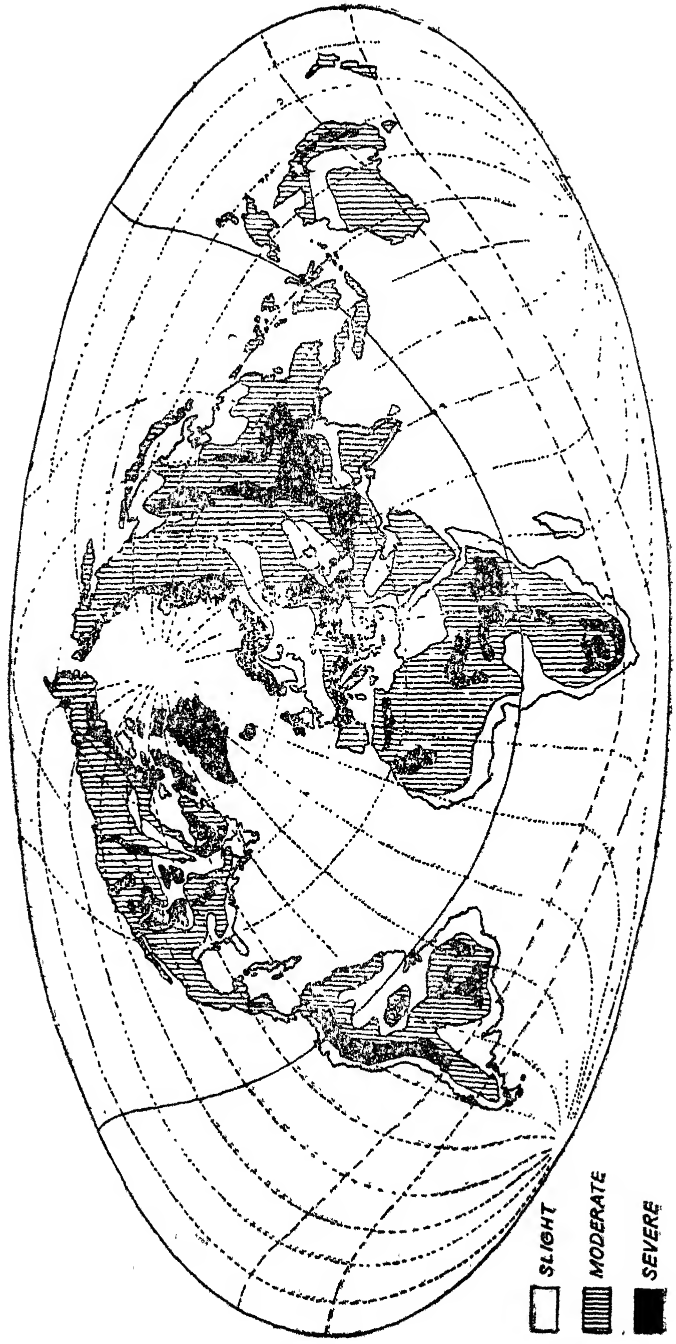

Fig. 6·7. Intensity of Soil Erosion

amount of soil lost by erosion ranges from 1 to 115 tons per acre (0·4 hectare) in different parts of India.[1] Erosion is a serious problem in the northern mountainous regions of India. "Unrestricted grazing and browsing of local animals and the buffalo herds of Gujars and flocks of sheep and goats of nomadic Gaddis have severely damaged the forests in the Himalayan Beas-Basin and there has been a great increase in soil erosion " Kayastha goes on to say that "Hills in the Nurpur are badly denuded like the hills of Siwaliks of Hoshiarpur...In Dlhra erosion is extremely severe and so also in Hamirpur.

In Mandi district, the catchment area of Uhl river is threatened with erosion......Soil erosion is much seen in Sarkaghat and Joginder nagar. Land slips can be seen in the vicinity of the Mandi town and in undemarcated areas of forest in Chachiot. ...In Kulu valley large extensive slopes are getting eroded in undemarcated forests and pasture lands. Throughout Kulu valley there are evidence of abandonment of cultivation."[2]

The erosion of this valuable resource is also a national problem in Southern India, where land is "sculptured here into an intricate pattern of gullies and ravines separated by sharp spurs and buttresses."[3] Similarly in Chota Nagpur plateau "the gully heads have been making alarming headway into the cultivated fields annually. In Maharashtra, over 70 percent of the cultivated land had been more or less affected by soil erosion, 32 percent of the land being highly eroded where crop growing was not possible at the time. In Sholapur district, it was observed that nearly 17 percent of the land under medium depth (more than 18 percent) was converted into shallower soils within a period of 75 years."[4] About one-fifth area of Indian Republic is under the menace of erosion. It is any agreed fact that "erosion, low yields and rural poverty are all symptoms not the primary causes, of maladjustment between the people and the soil,"[5] but it is an important symptom of bad relationship of man with soil resources.

ECOLOGICAL FACTORS AFFECTING THE EROSION OF SOIL RESOURCES

The extent to which erosion is liable to occur will vary with the conditions, but at any point its incidence is determined by the following factors—(1) The configuration and particularly the slope of the land; (2) the erodibility of the soil, (3) The amount, distribution and intensity of the rainfall, (4) The vegetal cover and (5) the system of husbandry and soil management practised.

1. Topography and slope of Ground are important ecological factor

Although soil erosion is frequent through out the world, it operates most intensely in the hilly regions. The precipitation often

1. Russel, G. Report on the work of Imp-council of Agri. Res. p.68.
2. Kayastha, S.L., The Himalayan Beas Basin, pp. 64–66, 1964,
3. Spate, O.H.K., India and Pakistan, p. 12, 1957.
4. Rao, Raman. M.S V., Soil conservation in India, p. 24, 1964.
5. Gorrie, R M., op cit, p. 1. 1946.

occurs in torrents which instead of sinking into the ground, as the light drizzles do, washes away the top layers of the soil. The steep slopes of the hills further stimulate the eroding power of the rain water. The soils are very thin and all exposed slopes are susceptible to serious sheet erosion or gullying. Erosion may be of little consequence for hilly tract but is of great significance to the plains. For example, the whole basin of Kosi river is threatened by this erosion, as a result of which the rivers bring with them millions of tons of sand and detritus annually. When the rivers reach the plains and below and the stream flow slackens the load is dropped and gets deposited in their beds. This leads to choking of river channels which in turn increase the flood danger and induces shifting of the course which brings disaster in its train to the whole country-side.

The river Chambal has cut more deeply than the smaller streams into this great mass of Archaean formations, and the most rugged topography is found in its vicinity. The smaller streams must, or course, cut to practically the same depth to reach the Chambal.

2. The Erodibility of Soil

Both surface erosion and deep gullying are considerably influenced by the type of soil of the world, although a given soil type may not behave consistently under all conditions and no type of soil is entirely safe from erosion. Thus sandy porous soils of the world are in general least subject to gradual weathering-down by water-action, since they are capable of absorbing a great amount of water in ordinary rains. On the other hand, if the rate of percolation is prevented by frost or by even thin strata of clay, the very lack of "binding" qualities in the sandy soils permits them to be moved at a very rapid rate. Again, however, the coarseness of the material may cause it to be deposited before it has been carried any great distance.

3. The Amount of distribution and intensity of Rainfall

As regards rainfall, Tempany writes, "it is not so much the amount of rain that falls during the year that is important, but rather that how it comes and when it comes. A single heavy fall of rain in a few hours may occasion very severe soil losses and damage, while the same precipitation distributed over an interval of several days or weeks can occasion little harm............ . The rate of movement of water depends upon the slope of the land. Other things being equal, the steeper the slope the more rapidly does water run down it, and rapidly moving water has great erosive power. Theoretically, if the rate of flow is doubled, the scouring capacity is increased four times, the carrying capacity thirty two times, and the size of the particles carried, sixty-four times".

Amount and rate of rainfall directly affect erosion. Data are not needed to convince even the most casual observer that heavy and rapid downpours are much more likely to cause erosion that equal quantities of rain falling over longer periods. This is

so generally fixed in the lay mind that the local language has been fitted to express the relationship. Thus a slow, steady rain (*rim-jhim Varsha* in local dialect) is commonly called a "ground soaker" while a dashing rain (*bouchar*) is in many localities referred to as a "gully waster".

4. The Vegetal Cover

The most potent and common causes for erosion in the world are deforestation and overgrazing. Throughout the world, as population has increased, more and more forest has been destroyed mainly by grazing, cattle feed on grass and herbs and green bushes. Their numbers are never limited to the fodder available. For grass to grow and persist in the face of grazing, the climatic condition must be such that rain falls in light showers at intervals. Whereas throughout the lesser Himalaya and Foot Hills, for example, the bulk of rainfall occurs in two and a half months of the summer monsoon. Then there is a flush of grass and the cattle get enough to eat ; but during the long periods of drought, the grass is grazed to the ground and torn out by the roots by the hungry cattle. When the drought is broken by storms the top-soil is washed away from the bare pastures and they deteriorate. According to Mr. and Mrs. Ehrlich[1], "Man's activities has already produced a great increase in the amount of desert and wasteland... The vast Sahara Desert itself is in part man-made, the result of overgrazing, faulty irrigation, and deforestation, combined with natural climatic changes. Today Sahara is advancing southward on a broad front at a rate of several miles per year. The Great Thar Desert of western India is also partly the result of man's influence. Some 2,000 years ago, what is now the center of this desert was a jungle. The spread of this desert has been aggravated by poor cultivation practices, lumbering, and overgrazing. Man's activities can lead to repitition of the Sahara and Thar stories in many parts of the globe." Excessive grazing in Rajasthan not only destroys the grass but compacts the soil, and many pastures, ruined by the hoof and teeth of countless hungry animals, are pastures only in name.

Under a natural vegetative cover, a certain amount of erosion takes place; but the rate of soil formation largely balances the loss. "Under a cover of natural vegetation erosion is restricted to the geologic norm," that is, the rate of soil formation is generally at least as great as that at which it is washed away. Removal of the natural vegetation, particularly if accompanied by cultivation, may lead to very rapid soil losses.

5. The System of husbandry and soil Management Practised

In Agricultural land of the world crops vary widely in their effect on erosion losses. Unsuitable methods of cultivation and

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1. Paul R Ehrlich and Anne H. Ehrlich, Population Resources Environment, issues in Human Ecology p. 202, 1970.

the absence of precautions to ensure the conservation of soil may lead to severe losses from erosion. The first step is to stop the type of misuse of land which has caused the trouble whether this be deforestation, fire, overgrazing or excessive cultivation of steep slopes.

Nothing is more serious among the agricultural problems of the world than the lack of realisation of the loss that the countries are suffering through soil resion. Thousands of tons of good soils are being washed away every year to sea without the slightest attempt being made to check it in some measure. This loss is greater in India than in most other countries, because of the nature of the Indian rainfall and mismanagement of land resources. The huge rainfall of the country which ultimately causes great floods in the big as well as the small rivers in India carries away large quantities of soil from one part to the other and finally to the sea. The extensive areas of the ravine lands in the neighbourhood of rivers are a sufficient proof of this. The pity of it is that we ourselves lend a helping hand to the running water to carry away our soil.

The problem of soil erosion is a complicated problem. For soil erosion varies from place to place according to character of the soil, according to the slopes of the ground, according to the vegetation cover, according to the use to which the soil is being put, and according to the nature and the amount of rainfall. The solution of the problem lies, therefore, not in any one fixed method but in adopting several methods that will take into consideration all the above factors. The main object is to retard the speed of run-off. Planting of trees, regulating grazing, building of dams across the ravine lands, and contour terracing are some of the methods that have been followed in foreign countries to check soil erosion.

SOIL CONSERVATION

In general terms, soil erosion is caused by water running from higher to lower levels over the surface of the ground. Soil conservation, therefore, means either decreasing or diverting the runoff, or both. "Soil conservation in its widest sense includes not only control over erosion but all those measures like correction of soil defects, application of manures and fertilizers, proper crop rotations, irrigation, etc., which aim at maintaining the productivity of the soil at a higher level." In this section of this chapter, however, we are concerned only with the measures for control over soil erosion, which is one of the most serious problems facing the world.

Various methods of soil conversation have been carried out by the farmers of the world since ago. The methods are not scientifically designed nor are they systematically applied often they are successful through imperfect; they have been developed on sound principles but they need improvement and extension. Thus the possible methods are—

1. Terraces control runoff and reduce erosion.

2. Contour cultivation,
3. Crops and crops practices,
4. Increased use of manures,
5. Keeping the soil covered,
6. River embankments,
7. Control of rock washes on steep slopes.

Terraces Control Runoff and Reduce Erosion—One of the most common methods of reducing runoff velocity is to break a slope by terracing. Terracing is the oldest known method of stopping erosion in hills. Contour terracing means making a level terrace on elevated ground running in the direction of the contour and not across it. Thus, the water in the terrace flows only slowly and does not cause excessive erosion.

Contour cultivation—Ploughing along the contours on the sloping lands reduces considerably the soil loss by erosion and the total annual runoff increasing thereby the crop yields. In some localities of Africa, plantation is on ridges mostly down in horizontal row. Now a South African conservation slogan runs: "Plough on the contour, plant on the contour, irrigate on the contour, if you want your children to inherit your farm [1]" Contour cultivation method has been proved effective in reducing runoff and erosion in Nilgiri Hills.

Crop-Rotation—The aim of the farmers in crop rotation should be to keep the land under protective cover for as greater a proportion on the total time as possible, lessening thereby the soil loss by erosion.

Crop rotations are followed for the following reasons—

1. In order to maintain productivity and yields.
2. Systematic farming.
3. It helps to control weeds, insect pests and plant diseases.
4. It helps in maintaining organic matter and nitrogen.
5. It lessens soil loss through erosion.
6. It keeps the soil occupied with crops for most of the year.

Increased used of Manures—Through manuring the farmers can check the deflection of soil nutrients which takes place with continuous cropping. Manures can be animal and plant residues, artifieial fertilizers or green crops. They ensure yet another aspect of soil conservation viz; the building up of soil productivity.

Keeping the Soil Covered—Grasses are even more firm protectors of soil than the trees, but the grasses too are destroyed by over grazing, making the earth bare of any vegetation. Here we do not mean that the animals should not at all be allowed to graze, but they must be prevented from overgrazing. Overgrazing in the local grasslands must strictly be prohibited. To solve the problem of animal fodder, green grasses should be grown in the fields when they lie follow. This will result in stimulating the fertility of the soil as well as solving the fodder problem.

1. Anderson, M S.—Geography of Living Things, p. 162.

In the USSR, where there is no individual ownership of land, planning for soil conservation can be done easily, and the plans can be carried out in their entirety. "The soil problems of the USSR are in many ways similar to those of the United States : each possesses a vast area of flat or rolling plains with a continental climate, each has a great and growing industrial population, and each relies largely on soil of the black-earth type for its heaviest cereal harvests. But though the USSR has more desert, more almost useless Tundra land, and a more extreme climate, she has a totalitarian economy, and can initiate and carry out schemes on a continental scale, with the certainty that everyone concerned will cooperate, she will have no difficulty over compensating evicted farmers, or persuading unwilling farmers to sink in the land money from which they will get no immediate return."[1]

River Embankments—The swift flowing rivers of India often overflow their banks in the rainy season and due to the greater slopes their velocity is intensified and the eroding power increases. Many smaller rivulets erode every year thousands of tons of fertile soil which is wasted for nothing.

A recent calculation published by the United States Soil Service, quoted by Fairfield Osborn, states that in that country, the richest and most productive in the world, the country that is going to ensure enough food for the under nourished millions in the rest of the world, "soil losses by erosion from all lands in the United States total 5,400,000,000 tons annually. From far lands alone, the annual loss is about 3,000,000,000 tons, enough to fill a freight train which would girdle the globe 18 times.........In a normal production year, erosion by wind and water removes 21 times as much plant food from the soil as is removed in the crops sold off this land." Now most Americans appreciated the value of crop rotation, manure, keeping up organic matter, erosion-prevention measures, and other good practices.

In the USSR the runoff shows both a spring and an autumn maximum. The most disastrous floods and erosion are associated with the melting snows of spring and with the occasional but heavy rains of late autumn and early summer. So "Russia is embarking on immense schemes to rehabilitate her soil, by reafforesting parts of the treeless steppes so as to make them more productive, by deflecting some of the great rivers into new courses and using them to irrigate lands now too dry for crops......If she succeeds in this great attempt, even with all the advantages on her side, she will still have achieved a victory immensely more important to the human race than that of Stalingrad, she will be the first great country of modern times to find a working solution to the problem of man's relations with the soil, the biggest of all the problems at present facing mankind on this planet."[2]

Soil conservation actions would substantially affect the agri-

1. Anderson, op. cit., p. 165.
2. Anderson, op. cit, p. 166.

cultural practices. Colin Mahar has very aptly obsesved that "Soil conservation can only be successful if it related to improved husbandry, including a rotational system with grass leys and the maintenance of soil fertility and soil structure by all the methods known to the good husbandman. Soil conservation methods which are not based on this are waste of time and money and will not have lasting results in preventing the deterioration and ultimate ruin of the land."

World wide Conservation

Interest in soil conservation lagged during world war I and the agricultural depression of the 1920's. H.H. Bennett[1] during his soil surveys, persistently calling attention to the serious erosion of soil resources and trying to arouse interest in a corrective program. By the second half of the 20th century, conservation had gained support throughout the world. The movement took a big step forward in 1929, when many countries approved the establishment of soil conservation experiment stations to (1) measure the rates of soil and water loss, (2) determine the extent and location of damage by erosion, and (3) develop methods for controlling erosion.

More than fifty countries in North and South America, the Mediterranean region, Asia, Australia and Africa had established organized conservation programs and about forty other countries were applying conservation measures. In India, there are many stations in operation gathering the information needed for an attack on the erosion problem of this valuable resource.

1. Smith, Guy Harold, Conservation of Natural Resources Edited, p. 10, 1965..

CHAPTER 7

WATER RESOURCES

Water is a priceless natural gift but is not an ultimated constant. Human history has revolved around conflicts over water and many civilizations have dwindled for mismanaging this most prime natural resource. Though there are nearly 480 million cubic kilometres of water on our planet inside our planet and above it, nearly 3 million cubic kilometres are available in the form of groundwater and less than 1/48th of a cubic kilometre in the air and skies as shown in Fig. 7·1. Even a minor variation within

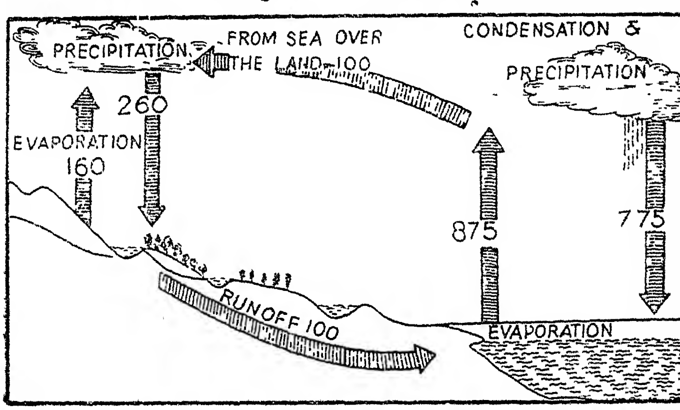

Fig. 7·1. Hydrological cycle (data from Borgstrom) in cubic km /perday

these three categories of water can lead to the destruction of our civilization, and the way we are progressing we have already made substantial changes mainly reduction and over-utilization in the water vapour in our atmosphere and the ground water resources. All life needs this simple substance.

Fresh water is even more limited and water cycle on earth is like the blood system in man or the respiratory system, without which no life can survive. Parrault and Mariott first proved that precipitation as rain and snow cannot account for the vast amounts of water in the rivers, and the soil had to be porous to receive, absorb and delay this flow. The distribution cycle of water was finally clarified by Harley. This explains the hydrological cycle which had puzzled man earlier. 1/48th million cubic kilometres is always present in the atmosphere and if all this fell as rain the entire earth would receive only 25·4 mm. of rain-fall. That is why turn-over has to be rapid, and over 12 days the entire 1/48th million cubic kilometres of water falls and is subsequently replaced

by evaporation and drainage. About 1/16 million cubic kilometres of water evaporated annually, mainly from the oceans. 1/96 million cubic kilometres evaporate from the lands and lakes and moist soils and most important, through the leaf surfaces of living plants, the total process being called evapo-transpiration. Evaporation might be expected to be maximum over the equator but this is not so, because of the cloud cover. Fig 7·1 shows the Hydrological cycle.

Classification of Water Bodies

From this standpoint the following two main geographical types of water bodies may be recognized : as shown in Fig. 7·2.

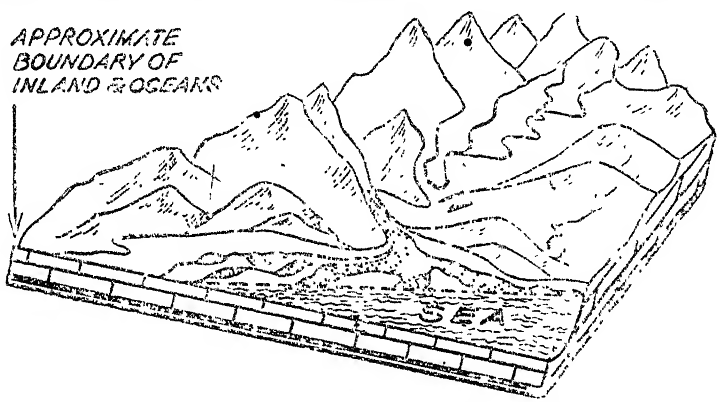

Fig. 7·2. Classification of water bodies

1. Outer envelope of lithosphere—The outer envelope constitutes the limit of the territorial seas and oceans. They cover nearly three fourths of the earth's surface to a average depth of about 3600 metres, with a maximum depth near the Philippine Islands of 9640 metres. Like the air, the oceans are the seat of incessant activities ; and where they come in contact with the lands, at their borders, the effect of these activities is extended to a modification of the land itself.

The ocean is profoundly affected by the atmosphere ; and it, in turn, is greatly influenced by the oceans. The ocean modifies the temperature of the air and supplies by far the greater part of its water vapour. Thus there is an intimate mutual reaction between the two elements of air and water, and between these and the surface of the lithosphere.

2. Inland waters of lithosphere—The inland waters of rivers. lakes and that below the ground surface duplicate these values of the sea and add still some of their own. All three *i.e.* rivers, lakes and ground water forms of inland waters give man his most basic, resource—his water supply for domestic, agricultural, and industrial purposes.

Outer Envelope of Lithosphere

The outer envelope of lithosphere *i.e.* oceans ane seas forming more than three fourths of the earth exercised a powerful influence on the life of man. They provide food and protection from aggression, act as highways to far-off lands and control the weather. They are the storehouses of huge quantities of valuable minerals; corals, pearls, medicines and a myriad of living things.

The phytoplanktons, known popularly as the grass of the seas, are the beginning of the chain of life. They trap solar energy and convert it into food. The seas have induced man to cross them and rewarded him with the discoveries of new lands to colonise.

Yet our knowledge about the seas is nothing more than a drop in the ocean and oceanography still remains a field unexplored, as vast and deep as the oceans themselves.

Size and Shape

About 71 percent of the total surface of the earth is covered by water, of which the greatest amount lies in the Southern hemi-

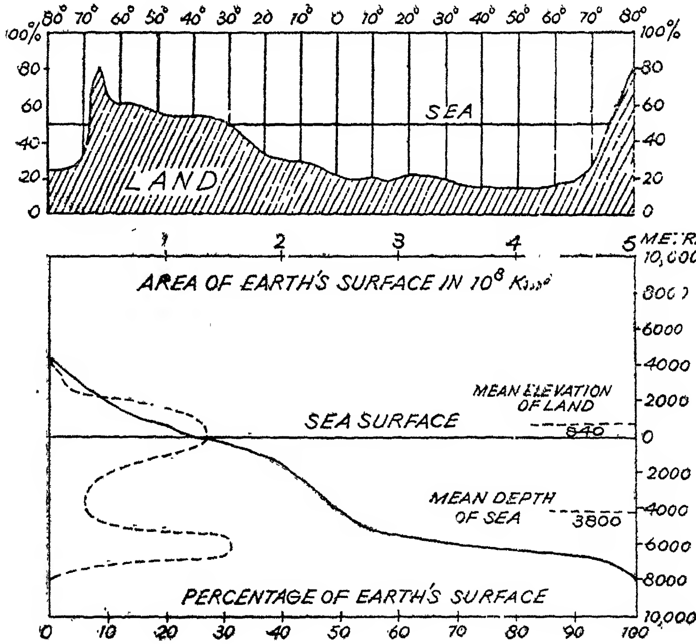

Fig. 7·3. Comparative Areas of Continents and Oceans.

sphere. For the most part, the ocean floor can be compared to a great basin of 5400 to 7300 metres in depth. There is evidence to show that the ocean bed is marked by the same kind of irregular relief as characterises the land surface as shown in figure 7·3. An

important feature of the irregularity of the ocean bed is the presence of the submarine canyons where the depth of the water is several kilometres. Besides the submarine cayons and deeps the presence of several sharp ridges, almost like cliffs on land, on the ocean floor has also been established.

Atlantic ocean—The deepest parts of the Atlantic lie on both sides of a central challenger ridge running from north to south. Wyvill Thomson ridge unites Britain with Greenland via Iceland, while from a third rise the West Indies. The continental shelf is broadest off North-west Europe, around Newfoundland and east of Patagonia. Hudson Bay, the Baltic and white sea are all also shallow. Its area is about 82,441,500 km^2.

The Pacific Ocean—The ocean is the portion lying between Asia and Australia on the west, and North and South America on the east. It has an area of some 165,245,200 km^2. The Pacific ocean is deepest east of the Kurile and Japanese Isles, and off Newzealand. The islands fringing Eastern Asia and the East Indies rise from shallow submarine ridge. The Bering sea, and the seas between Eastern Asia and the island girdle, are all shallow.

The Indian ocean—This ocean is surrounded by land in the west, north and east—Africa on the west, Asia on the north, Polynesia or Indonesia and Australia on the east. It extends in a southerly direction as far as the Antarctic circle. Its area is approximately 73,442,700 km^2. Some shallow and island studded areas extend between south India and Madagascar.

Portions of these oceans more or less enclosed by land are referred to as inter-continental and small seas, such as Baltic sea, Mediterranean Sea, Red sea, Japan sea etc.

The details about the various oceans and seas have begn given in table 7·1, so that an exact knowledge about the expanse of sea water may be comprehended.

Table 7·1
Area and Volume of Oceans and Seas[1].

Name	Area km^2	Volume cu. km.
Atlantic ocean	82,441,500	323,613,000
Indian ocean	73,442,700	291,030,000
Pacific ocean	165,246,200	707,555,000
Oceans	**321,130,400**	**1,322,198,000**
Arctic Sea	14,090,100	16,980,000
Malay Sea	8,143,100	9,873,000
Central American Sea	4,319,500	9,573,000
Mediterranean Sea	2,965,900	4,238,000
Inter-Continental Seas	**29,518,600**	**40,664,000**
Baltic Sea	422,300	23,000
Hudson Sea	1232,300	158,000

1. Encyclopaedia Britannica, Vol. 16, 14th Ed. 1929, p. 680.

Red Sea	437,900	215,000
Persian Gulf	238,800	6,000
Small enclosed Seas	**2,331,300**	**402,000**
Bering Sea	2,268,200	3,259,000
Okhotsk Sea	1,527,600	1,279,000
Japan Sea	1,007,700	1,361,000
E. China Sea	1,249,200	235,000
Andaman Sea	797,600	694,000
California Sea	162,200	132,000
North Sea	575,300	54,000
English Channel & Irish Sea	178,500	10,000
Laurentian Sea	237,800	30,000
Bass Sea	74,800	5,000
Fringing Seas	**8,078,900**	**7,059,000**
Seas enclosed and Fringing	**39,928,800**	**48,125,000**
Hydrosphere	**361,059,200**	**137,032,500**

IMPORTANCE OF THE OCEANS TO MAN

A geographer's interest in the oceans lies in shorelines and tides which affect the development of ports, and the ocean currents which influence the climate and fisheries of coastal regions. Without water there could be no life on the earth The abundance of overground and under ground water on our earth is in complete contrast with the conditions obtaining on our neighbouring planet the mars and our satellite the moon which have little or no water. Considering the needs of organic life on the earth however, the area of the oceans here is none too large. A smaller area of the oceans would not be enough either to keep the life processes going by supplying the needs of water, or to regulate the temperatures on land. The extremes to which the unregulated temperatures on land could go would destroy practically all life on it. Oceans form so great a part of man's environment that they have an overwhelming influence on man and his activities. Ocean engineering and related sciences are fast gaining international importance.

MAN'S RELATION TO WATER RESOURCES

1. Oceans can Yield Bounties

Nature has endowed the oceans with fantastic resources. The chemical and mineral content of the ocean's water mass is staggering. According to a recent estimate, a cubic kilometre of sea water contains in solution up to 25 tons of gold and 45 tons of silver; 10 ro 30 tons each of copper, manganese, zinc and lead; seven tons of uranium, 50 to 350 tons of arsenic; four million tons of potassium sulphate, 18 million tons of magnesium chloride, 120 million tons of sodium chloride, and a host of other minerals. If one multiplies these figures with the 480 million cubic kilometres of the sea water found in the world's oceans, the figures would indeed be astronomical.

The bounties of oceans, if tapped properly, can yield significant break through in our national economy. Minerals, too, are known to be plentiful. Heavy-mineral-rich beach sands containing monazite and ilmenite have been found along the Kerala, Tamil-Nadu, Maharashtra, Andhra Pradesh and Orissa coasts. Ferro-manganese nodules of 2·5 cm. size and appreciable quantities of nickel and cobalt, besides 15 to 30 percent manganese, "have been sampled from various locations in the deeper parts of the Indian ridge and west of it, in the south-east Indian Ocean."[1]

2. **Effects on Marine Life**—The sea, according to Ommanney[2] "is a realm of life even more populous than the dry land. Not only the seashore and the banks which are the home of many sorts of fish but the open ocean also many hundreds of miles from land, supports a plant and animal population of the greatest diversity and complexity."

The vast abundance of organic life in the ocean, especially in the upper layers and along the coast, has long been known. Many coast lines are bordered with luxuriant seaweed growth, encrusted with barnacles, or fringed by coral reefs, mangrove swamps or salt marshes. There is wider distribution of organisms in the ocean than on the land (1) because there are less differences in temperature, (2) because the medium in which they live is in motion, (3) because, excepting along the coast, there are fewer variations in environment.

Upon the abundance of life in the ocean, Murray writes as follows : "we now know that the whole of the surface waters of the ocean are crowded with minute unicellular algae, which are ever busy, under the influence of sunlight and chlorophyll, converting the inorganic substances in sea water into organic compounds, which in turn supply not only the food of the vast majority of marine animals which live in surface and intermediate waters, but also of the myriads of creatures living near and on the sea floor, miles beneath the level to which the sun's rays can penetrate. The surface waters may be regarded as vast floating meadows, each great region having its own species and a soil (as it were) and other conditions which make for abundance or scarcity. The vegetable matter, in the form of phytoplankton, present in the surface waters of the ocean down to a depth of 200 fathoms, is probably much more abundant than that in the layer of vegetation which covers the land surfaces of the globe. The bodies of these minute unicellular algae, which often have calcareous, siliceous, or chitinous shells, fall to the bottom after death, together with the dead bodies of the animals which browse in these meadows, accumulating on the surface of the deep sea oozes and clays, they supply nourishment for the creatures that crawl over the bottom of the sea "[3]

1. Commission on oceans and ocean Resources, 1973.
2. F. D. Ommenney—The ocean, p 29, 1955
3. J. Murray, The ocean, p. 256, 1912.

Life along the Littoral zone or coast —the great variety of life in the littoral zone is due to the variations in the environment—the variations in temperature, exposure, nature of coast, salinity, oxygen supply, and food supply. Several of these factors also influence the abundance of life, but none more effectively than oxygen and food supply. In these respects the littoral zone is, in general, favourable to abundant life, for the water is aerated in the surf zone, and both oxygen and food supply are brought to the animals by the waves and currents..' The sea is so excellently suited to the development and maintenance of life that it is natural to look upon the shallow coastal seas as its brithplace and cradle.' [1]

The coast line presents conditions intermediate between those of the land and sea ; and accordingly there are resemblances between the life in the two, while some of the species go freely from one to the other. The Polar bear, for instance, is probably to be classed as a land animal, though it spends a large share of its time on the ice floating in the sea ; the seal and walrus are doubtless to be classed as marine animals, though staying out of the water, on the shore or the floating ice, large part of the time. Many birds live in the sea or in the air above the sea the greater part of the time, coming ashore mainly for feeding, so also do the marine turtles.

Life at the surface or Pelagic forms—The basis for the existence of the pelagic animal life is the abundant p'ant life, notably the microscopic algae. Many of these plants, such as the diatoms, have silicious tests, others, *Coccolithophoridae*, Calcareous. Upon the minute plant and animal life of the surface even huge whales depend for their food. The most important pelagic forms of life are numerous fishes, some like the herring and mackerel, swimming in great distance, others moving singly like the shark and swordfish. The whale also roams in the surface and upper layers of the ocean. A multitude of floating species of jellyfish and other forms of animal life also inhabit this zone, and great numbers of the young of larger animals, especially in the coastal waters where many of the fixed forms have a free swimming larval stage.

Life on the ocean Bottom or abyssal zone—since no plant life exists in the zone of darkness of the ocean, the animals of the sea floor are wholly dependent upon the supply that rains down upon them from the densely inhabited upper layers. Life on the ocean bottom is necessarily limited by this food supply, but it is sufficient to support a varied and abundant life where other conditions are favourable. Large fertile areas are to be found in every ocean except the Indian and Arctic oceans.

(3) As a Source of Mineral Wealth

With rapid industrialisation all round the world the demand for minerals, especially metals, has increased at an unprecedented rate. At the same time, despite increased utilization of scrap and

1. F. D. Ommanney, The ocean, P. 31.

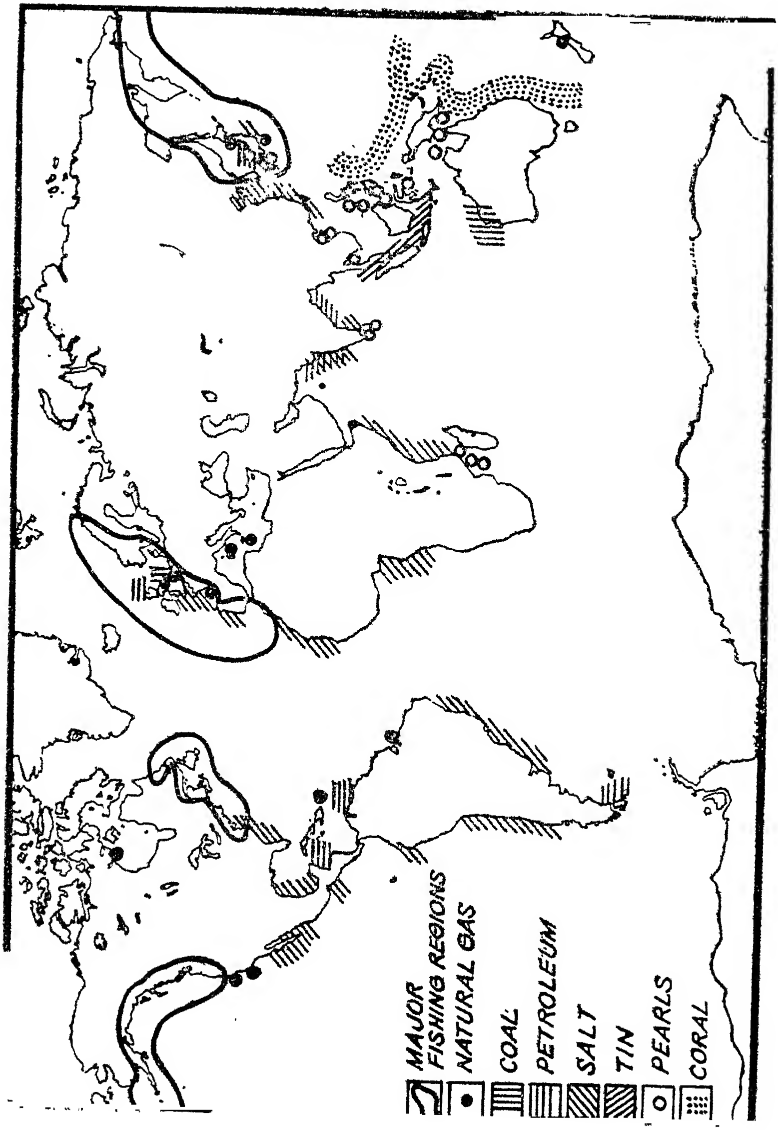

Fig. 7·4. Fertile Areas of Sea

waste and substitute materials, terrestrial resources of most metals are getting depleted too quickly to last any length of time. Fortunately, the oceáns that cover more than three-fourths of the globle hold an abundance of minerals which man can exploit.

Apart from the minute quantities of many metals that are present in sea water, the mineral wealth on the sea floor is enormous. But till recently, most sea mining activities like dredging for gravel, oyster shells, and placer depoists of gold, diamond and tin, were limited to the shallow waters of the continental shelves. Deep sea mining was considered to be economically non-feasible. The picture is, however, changing rapidly and possible techniques for ocean mining are being developed.

The most interesting accumulation of minerals on the sea floor are the mineral lumps made up primarily of manganese, iron, nickel, cobalt and copper, called manganese nodules, which are strewn over large areas of the ocean floor like pebbles on a beach.

Recovery of metals from the nodules is relatively simple. Crushed nodules are bleached by acids or alkalies and the constituent metals separated from the resulting solution by electorlysis, precipitation or iron exchange. Although dredging is one of the most convenient methods of deep ocean exploitation, it is by no means the only technique of tapping the ocean's mineral resources. Other methods are also being tried out for procuring minerals from under the sea bed. Besides, newer techniques for detecting and assessing subsea deposits are already in the development stage. There is little doubt that in the foreseeable future improved technology will make marine mineral sources an attractive alternative to our dwinding terrestrial reserves.

Over a period of seven years, several sites have been located by U.S.A. in the Pacific and the Atlantic using scanning TV systems which are suitable for commercial exploitation. Each of these sites, it is believed, would yield more than a billion pounds of nodules per year at the surface, and possibly an equal quantity from below the surface. The yield potential of these oceanic deposits can be judged from the fact that the total amount of manganese contained in the area of a single site is estimated to be approximately equal to the annual world production of the metal.

The problem of raising mineral nodules from the sea bed of an economic rate, which was considered impossible, has been solved by designing entirely new dredging systems. An air lift dredging system has recently been tried out in the U.S.A. The device, which uses compressed air for lifting the dredged nodules, operated successfully at a depth of 900m. A commercial system is now being planned for operations at depths of 3600 to 6000 metres.

The ocean is also a potential source of vast amounts of energy. Coal can be obtained from ocean bottom. A coal deposit has been discovered under the Indian ocean beds near Australia.

This is the first time that coal has been discovered under deep sea bed. The discovery has been made by the Scripps Institution of Oceanography and Global Marine Incorporation which works for the United States Science Foundation. The find is considered significant because the fossil fuel reserves in most parts of the world will be exhausted by the turn of the century. With a major breakthrough in sub-marine mining technology expected in the next 10 to 20 years man will be increasingly looking for mineral resources under the sea.

The site is 1,500 km west of Broome on the western Australian coast. The Indian ocean at this point is 6,243 metres deep and the hole was drilled to a depth of 521 metres from the crest of the Ninefyeast ridge.

The extraction of salt from sea water is an important mineral industry in numerous coastal localities. The largest production of salt for example, in India is from the western coast. Maharashtra state ranks first in salt production. Most of the salt in Maharashtra is made by the direct solar evaporation of sea-water. The factories at Dharsana, Bhoyandar, Bhandup, Uran and Mithapur on the eastern side of the Gulf of Cambay near Bulsar and Okha in Saurashtra belong to the Government. The other sea salt works are grouped within a radius of fourty eight kilometres of the city of Bombay. Ideal conditions for salt making are—

1. Proximity to the sea to have easy access to brine.
2. Scanty or no rainfall.
3. Strong insulation, which in turn depends on cloudless skies.
4. Moderate to strong winds.
5. Moderate to high air temperature with large deficiencies of moisture.
6. Moderate to high evaporation which depends upon the foregoing factors.

From this point of view the following are suitable areas for salt making in India—

1. The Saurashtra coast.
2. Southern half of the coromontal coast, between Nagapatam and Cape Comorin or Kanya Kumari.
3. Northern coast of Andhra—Tamil Nadu coast between Nellore to Gopalpur, South of Chilka lake.
4. The Sambhar Lake.

4. The ocean as an Environmental Factor

The ocean exercises a significant influence upon climate. There is a close inter-relationship of a complicated nature between the atmosphere and the oceans. The ocean is a great regulator and stabilizer of climatic elements and climatic changes. The distribution of temperature over the earth surface is greatly influenced by

the oceans. They have been regarded as "a savings bank for solar energy, receiving deposits in seasons of excessive insolation and paying them back in seasons of want."

Much has been written during recent years about the modifying influence of ocean currents upon climate generally, and in many cases the loose impression conveyed is that currents act in somewhat the same manner as the heating apparatus of a greenhouse. It should be understood that no body of water can by its temperature affect any air except that resting directly upon it, and neighbouring land can only be influenced when that air is transferred to it from the sea. The Gulf stream and the Labrador current both flow at a short distance from the east coast of North America, but their influence for good or evil upon the climate of that continent is extremely small, because the general drift of the atmosphere is from the land. The mixed waters of these currents, drifted across the Atlantic, almost along a parallel of latitude for a great port of the way, show no considerable excess of temperature, nevertheless the west coast of Europe has an energetic climate because the prevailing winds come from the sea.

The part played by oceanic currents becomes, however, important in relation to the fact that, other things being equal, a cold surface, by lowering air temperature, tends to increase pressure, and a warm surface, by raising air temperature, to diminish pressure. It temperature is below the normal in an anticyclonic area, the anticyclonic conditions will be strengthened : if it is above the normal, they will be weakened. Where the conditions are cyclonic, unusually low temperature weakens them, high temperature reinforces them. In the latitudes of the high-pressure belts the great oceans have currents moving poleward on their western sides, and towards the equator on their eastern sides; that is to say, in the west the water is moving from a warmer region to a colder, and on the east from a colder region to a warmer. As the temperature changes slowly, the surface on the west side is therefore relatively warm, and on the east relatively cold.

Another aspect of this action presents itself in the special case of the North Atlantic. The North Atlantic is connected with the Arctic ocean by three main channels, one between Europe and Iceland, another between Greenland an Iceland, and a third between Greenland and America. By a process which need not be discussed here the strong cyclonic winds in the Atlantic send vast quantities of relatively warm water northwards to the ice-encumbered regions of the Arctic; with the result that much of the ice is melted. Every season vast quantities of sea ice and glacier ice are drifted out of the Arctic. These cold surface currents naturally affect the temperature of the sea in the regions to which they flow, and the winds which blow over them are chilled in their passage. The cold climate of Labrador, Newfoundland and New England is in part due to the effect of the cold Arctic current transmitted to the land by the ocean winds.

The ocean drifts and currents have also important influence on

precipitation. Winds blowing over warm waters become charged with vapour, and this is, of necessity, partly precipitated when the air is chilled either in passing over cooler water or in rising over the land. It is due to the latter cause that there is so heavy a rainfall on the western coasts of Europe and America; while the former cause explains numerous fog belts. One of the foggiest places on the earth is on and near the Banks of Newfoundland, where the warm southern current and the cold Labrador current flow side by side in opposite directions.

5. Influence of oceans upon Navigation

The transformation of the ocean into a highway by the development of navigation is a late occurrence in the history of man and is perhaps the highest phase of his adaptation to environment. Moreover, it was adaptation to an alien and hostile element, whose violent displays of power recurrently stimulated the human adjustment between attack and defence[1]. The cheapest and most satisfactory means of communication is by sea-going vessels. The cost is solely in the construction and working of the vessel. The road incurs no expense and is free to all.

Oceans are no longer barriers as they were in the earlier days of civilization : they are links between countries, and the more advanced the progress of any people the greater advantage do they take of the ocean highway. Those countries with a long and easily accessible seaboard, that is accessible both externally and internally, are the more advantageously placed in developing trade. "The nation that does not touch the ocean is like a house that is not upon the street..... ......once a nation has reached the sea it has possessed itself of a part of the world highway that reaches everywhere and belongs to each and all who own even a tiny strip."[2]

Ocean currents have distinct influence on navigation by aiding or retarding the movement of ships, especially sailing vessels. The strong currents along the South American coast were a very decided factor in the movement of the small ships in which columbus sailed. Even the west wind drift of the North Atlantic produced sufficient effect upon the sailing vessels of colonial days to attract the attention of Benjamin Franklin The investigation which he undertook to explain the fact that from west-going boats went faster than east-going led to the first correct explanation of the Gulf Stream.

Ocean Commerce

Miss Semple[3] divides the maritime development into three geographical stages. They are—

"For the earliest stages of maritime development, only the smaller articulations of the coast and the inshore fringe of sea inlets count. This is shown in the primitive voyages of the Greeks, before they had ventured into the Euxine or west of the forbidding cape

1. Semple, op cit p 293.
2. R. Smith, Phillips & T. Smith—Ind. & Comm. Geog. p. 614, 1955.
3 Semple, op cit. pp. 301–302.

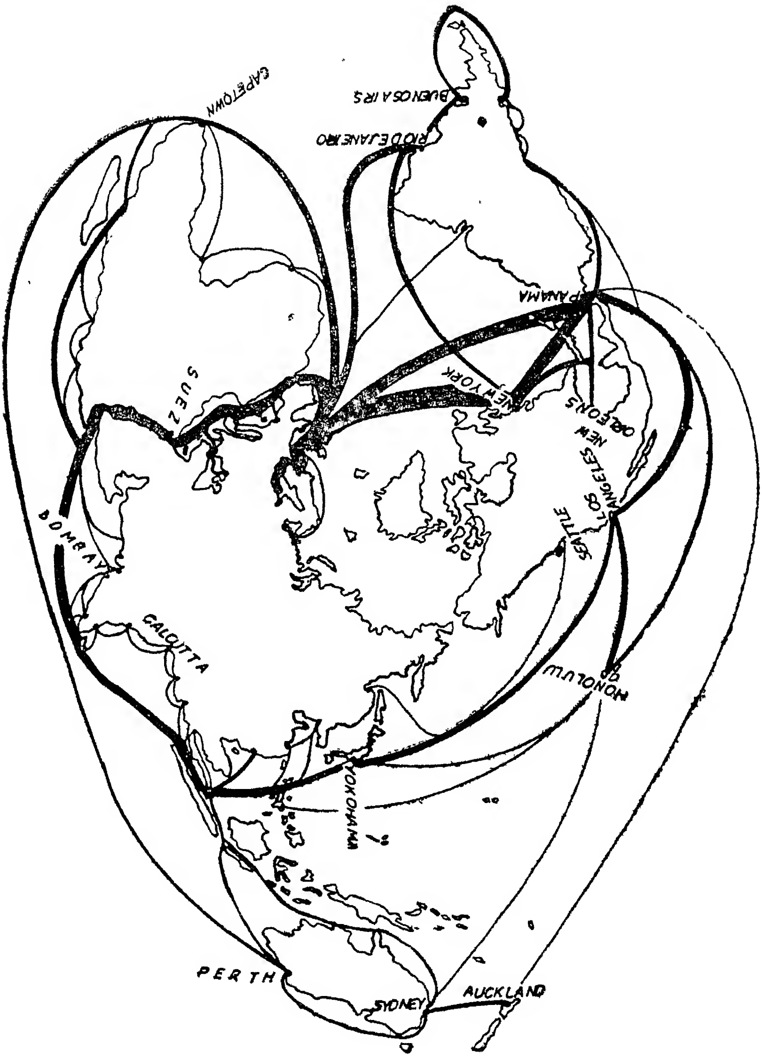

Fig. 7·5. Major Ocean routes

Malia; and in the "inside passage" navigation of the Indians of South Alaska, British Columbia, and Chile, who have never stretched their nautical ventures beyond the outermost rocks of their skerry-walled coast.

"The second stage is reached when an enclosed basin is at hand to widen the maritime horizon, and when this larger field is exploited in all its commercial, colonial and industrial possibilities, as was done by the Phoenicians and Greeks in the Mediterranean....
....

"The third and final stage is reached when the nursery of the inshore estuary or gulf and the elementary school of the enclosed basin are in turn out grown, and the larger maritime spirit moves on to the open ocean for its field of operation".

After Columbus all oceans were rapidly or slowly opened to trade. Today, however, major commercial activities wholly or partially centre around the oceans.

The major overseas trade routes are as follows :—

1. The North Atlantic Route—The North Atlantic route connects two continents that have long surpassed all others in manufacturing, transportation, finance and trade. The greatest volume of ocean traffic follows the North Atlantic route from British and Continental ports to the United States. This route links western Europe and eastern North America, two very productive areas and the two greatest markets on earth.

2. The Mediterranean-Asiatic Route—This route connects two great types of western civilization (as represented by Europe and America) with the Orient and its old Civilizations of India, China and Japan. The Mediterranean-Asiatic route passes through the heart of the old world, touches more lands and serves more people than any other route. It has been calculated that with its many ports of call it reaches one way or another about three quarters of the total poqulation of the globe. The Suez Canal is the chief nobal point of the route and generally called the life line of British empire in those days. "The wheat, wool, gold and copper of Australia, the wool and much of the mutton of New Zealand, the teas of India, Sri Lanka and China, the sugar of Java, the rice of Indonesia and Burma, the jute of Bangal and Bangla Desh, the cotton of the Deccan, the Sugar and Tobacco of the Philippines, the rubber of Sri Lanka and Malaya Peninsula, the dates of the Persian gulf, the coffee of Arabia, the Soyabeens of Manchuria, the petroleum of the Persian gulf and Burma, the clovers of Zanzibar, the pearls and pearl sheel of Burma and Australia the Copra of the Pacific Islands, the rubber, ivory and hides of East Africa—all pass through the Suez canal to Europe. In return there go eastward machinery fo all sorts, iron and steel work, manufactured cotton goods and clothing and endless variety of the industrial products of Europe's manufacturing activity. Some of

these Eastern goods go direct to America across the Atlantic, but America's share is small in comparision with the whole and much of it is transhipped in London."[1] In the modern world, the opening of the Suez canal has enhanced the importance of India's position. For the routes emanating from this canal and the strait of Malacca are forced to pass near India. The Indian ocean has very few islands to serve as supply bases for the ships. The ships plying to Australia, therefore, have to visit some port in India or in Sri Lanka. The most favourable ports on the Indian coast gradually developed into good seaports.

3. The Cape of Good Hope Route—This route connects the highly industrial west European civilization with the Oriental agricultural and pastoral economy of Australia and New Zealand.

The traffic of this route declined considerably after the opening of the Suez canal. Transiting this route are large tonnages of Australian and South east Asian food and raw materials in exchange for European manufactures This route is also known South African-Australian route and this is the only route which expanded colonization in African and Asian countries.

4. European-eastern South American Route—Another important ocean trade route across the Atlantic ocean is that between Western Europe and South America. This route extends from the Rio de la Plata (Argentina) north eastward along the South American coast to Cape Sao Roque (Brazil) where the route bifureates, the main branch continuing across the Atlantic to western Europe and the other branch turning north east to the United States. This trade routes links the agricultural and pastoral nations of South America with the highly industrial and advanced regions of western Europe and eastern United States.

The other important routes are eastern North American-east south American (from New York to Cape Sao Roque), North American-western south American (from New York to Punta Arenas via Panama canal), North Pacific (Vancouver to Yokohama) North American-Australasian (from New York and Vancouver th Sydney and Wellington Via Honolulu).

Between Atlantic and Pacific and Mediterranean and Indian ocean routes Suez and Panama are the vital man made gateways of commerce connects old and new civilization of east and west.

The Suez Canal

The Suez canal was opened in 1869. It is about 160 kilometres long, if we include the lakes it passes through, and is 11 to 15 metres deep. The width of the floor is 40 m and varies at the surface. Both depth and width are being increased. Suez afforded a new gateway to the Indian ocean. Fig 7·6 shows the link of Suez canal.

9. R.N. Rudmose Brown, Eco. Geog. pp. 170-171, 1929.

The tolls levied on goods and passengers are so heavy that some ships find it cheaper to go by the Cape route whenever the consequent delay is not important. The opening of the Suez canal saved approximately 5820 kilometres on the Voyage from London and Liverpool to Bombay as compared with the Cape route, 4800 km. to Yokohama, and 1600 kms. to Sydney.

About three-fifths of the vessels which pass through the canal are British. A railway follows the canal to Suez, and from Ismailia there is a branch to Cairo. A navigable fresh water canal from the Nile also joins the Suez canal here, and branches of it supply Port Said and Suez with fresh water. More than 12,000 vessels pass through the Suez canal every year. "Huge oil shipments from the Persian Gulf have been a bonanza for the canal company in the postwar era in spite of the completion of new pipe lines from Saudi Arabia to the Mediterranean. The average tanker pays about $20,000 in tolls for every round trip through Suez. In 1952 tankers accounted for nearly 50% of the total net tonnage of vessels with Cargo using the canal. Most of the tankers were American, British and Norwengian."[1]

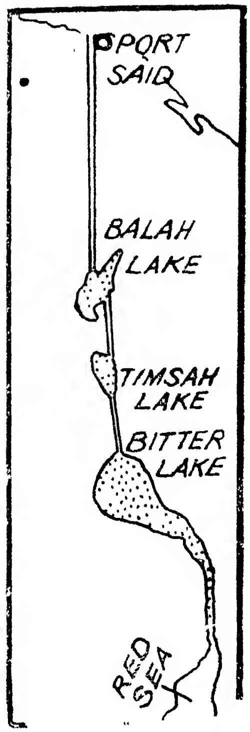

Fig 7·6. Suez Canal.

The Panama Canal

The Panama canal has been built between Panama and Colon-a route already traversed by a railway. It was made under the auspices of the Government of the United States, which purchased the land for 8 kilometres on each side of the canal. The canal is about 72 kilometres long, and involved a very deep cutting for a least 12 of these kilometres. On great difficulty in the work was the liability to sudden floods caused by the very heavy rainfall, which has necessitated

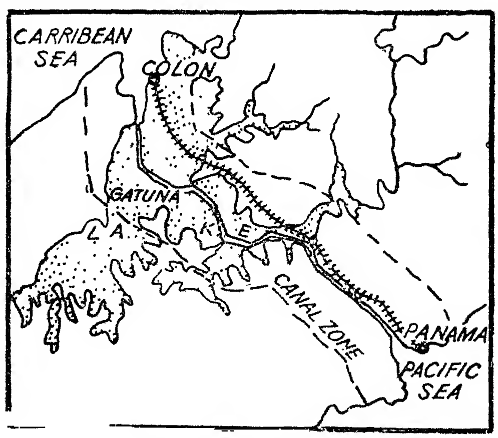

Fig. 7·7. Panama Canal

1. Smith, op. cit., p. 640.

the building of high embankments in places. The region was also unhealthy before steps were taken to reduce the risk of fever. Marshy lands around Panama is shown in Fig. 7 7.

The canal shortens the distance between New York and San Francisco by about 12596 kilometres by sea, and lessens very considerably the distance between western Europe and western America, and between the northern and middle parts of Eastern America and Eastern Asia. The table 7·2 shows the savings of distances by the Panama canal :[2]

Table 7·2

Savings by the Panama Canal

	Kilometres	Days at 10 Knots.	Days at 16 Knots
Liverpool to San Francisco	8000	23·1	14·2
Liverpool to Honolulu	6400	17·8	10·9
Liverpool to Valparaiso	2400	5·9	3·5
Liverpool to Yokohama	1004	2·4	1·3
Liverpool to Shanghai	4200	11·0	6·8
Liverpool to Sydney	2400	·6	·4
Liverpool to Adelaide	3628	10 8	6·1
Liverpool to Wellington	2496	6 0	3·5
New York to San Francisco	12596	32.3	20·0
New York to Honolulu	10576	27·0	16·7
New York to Yokohama	6016	15·2	9·3
New York to Sydney	6288	15·8	9·7
New Orleans to Yokohama	9120	23·3	14·4

It also slightly shortens the distance between Europe and New Zealand, but it does not lessen that between Europe and Asia or Europe and Australia. According to Smith and Phillips, "Eastern North America and north western Europe very definitely gained as a result of the opening of the canal, for they were placed much nearer by steamer route to all of western north America, western south America, and New Zealand. For eastern North America the canal has meant a great reduction in the distance to Japan and to all of China north of Hong-Kong, a factor that has unquestionably contributed to the rapid growth of trade with East Asia." According to these authors that the Panama canal is almost as definitely American in its function. Panama is also called the economic pulse of Latin America, especially the west coast countries.

2. Smith op. cit. p. 641.

6. Fish Farming on Ocean Floor

Japan, as a leading fishery nation, is moving towards the ultimate creation of "fish farms" on the ocean floor.

A three year project to breed fish in a sophisticated ocean preserve has just begun against the back ground of a growing international tendency to establish exclusive fishing zones, limit fish catches and claim rigts over continental shelves.

The breeding project by the Nishin Ocean Development Comany, formed last June 1972, will use a cylindrical fish preserve development by the Niigata Steel Works. The preserve —53 metres in diametre and eight metres deep–can contain in the same area twice as many fry (baby fish), as under existing fish breeding methods. A steel tank in the centre of the preserve can be moved by remote control from the coast so that the whole system will submerge to avert an approaching typhoon or to get colder water near the bottom in summer. Under the current coastal breeding system, appropriate topography has to be chosen in the first place to protect fry from Typhoons or tides.

They start in temperature-controlled ponds and then move to fenced-off sea water with a feed distributor. When old enough to find their own food, are turned into the sea. With this method, salmon and trout will have a commercial value in one year and tuna in two years at the longest. They also develop artificial feed–inedible protein, since fry at present must be fed with other kinds of fish.

They have started fish farming on the Pacific coast of ncrthern Japan. In future, they will be installed in waters up to 200 metres deep or on continental shelves along the Japanese coast.

Japan is the first biggest fishery nation in the world with a fish haul of 9,700,000 tons a year of which 5,000,000 tons are for domestic consumption.

Since 1962 she has bred more than 50 varieties of fish and crustaceans and artificially hatched millions of Spawn and released millions of firy a year. But fish, bred and caught now represents only two percent of the total haul or about 180,000 to 200,000 tons a year.

7. Ocean as Source of food supply—The 30 million tons of protein food extracted from the seas now is but a fraction of its vast potential. The great fisheries, which provide food for the millions of the world's continents, are situated entirely upon the continental shelf or upon the edge where the shelf steepens into the slope down to the abyssal plain. Several new forms of life have been discovered and the plankton -the minute, floating organisms of plant and animal origin, which inhabit the waters of seas, lakes, streams and ponds, and form the food of many fishes and other creatures. The principal fishing-grounds of the world are thus found on the continental shelves, where plankton abound.

Animal and vegetable plankton also form the food of the whale and cod. plankton, which consists principally of algae and diatoms, "is to the life of the sea what pastures are to the life of the land."

Fisheries

Fishing is an important industry in maritime regions, supply man with a not inconsiderable amount of food and furnishing employment to many of his numbers. Rich in proteins, vitamins and mineral salts, fish is a valuable protective food. It forms an important constituent of the diet over considerable areas of the world.

Besides articles of food, fish yields several by-products, such as fish oil, fish-meal, fish manure, fish maws and shark fins. The most important is fish oil, such as sardine oil and shark-liver oil which are now produced on commercial basis in parts of the world. The oil is used for the manufacture of paints, soft-soaps, for softening hides, for tempering steel, batching jute and after hydrogenation for the preparations of edible facts. Fish liver oil produces vitamins A and B, indispensable for wasting diseases. It is being manufactured, for example by the Governments of Maharashtra, Tamil Nadu and Kerala. The Government shark liver oil factory is situated at Kozhi Kode, Madras, which supplies shark-liver oil for use in hospitals and for sale to the public.

India has a coast line of about 4800 kilometres. The continental shelf is estimated at about 260,000 km^2 with an average width of about 56 kilometres. The continental shelf off the west coast is wider than the one off the East coast, extending in a few regions to 248 kilometres. The nutrient-rich deep waters of the west coast account for over 3/4th of the annual catch of about 900,000 metric tons of fish. The relative poverty of marine life of the Bay of Bengal is attributed to the presence of a large quantity of silt, and to the absence of large scale upwelling. The silt deposited by the major rivers of the East and the lack of geophysical turbulence have reduced the chemical and physical processes conducive to the growth of marine life.

8. Ocean a place of Dumping wastes :

Until recently the oceans with their vast area and volume seemed safe places for the disposal of wastes. According to the American Council on Environmental Quality, America dumped about 48 million tons of wastes into the oceans in 1968 from about 250 dumping sites. Britain dumps daily about five million cubic metres of domestic sewage, three million cubic metres of industrial waste, and seven million cubic metres of cooling water from power stations, Four million tons of colliery waste, etc., into the adjoining areas.

The damage that such indiscriminate ocean dumping can cause can be imagined if one takes a look at the New York harbour.

1. Am. Cou. Env. Qu. pp. 3–100.

The nearly 400 billion gallons of sewage dumped into the Hudson river each year has rendered the harbour area a "dead sea". 52 km^2 at the mouth of the harbour is totally devoid of significant marine life.

In India, the coastal zone, too, is being increasingly used for dumping wastes. During 1970, a seminar organised by the Bhabha Atomic Research Centre on river pollution, gave concern was expressed at the pollution of the Ganga River System, and other South Indian rivers. A detailed report on the industrial pollution of the Hoogly estuary was presented. It was agreed that there was a need to evolve and standardise methods for disposal of wastes. Waste disposal, has rendered desolate extensive areas of the oceans.

9. Ocean as a Potential Reserve

The pace of technological developments in ocean exploration has been such that it has given rise to an almost romantic picture of the future. It is possible that man will be able to journey in deep oceans water and stay there for weeks to work at such tasks as oil drilling, mining, gardening of undersea crops. Also in the realm of possibility are undersea hostels for vacations, dams to harness ocean currents for purposes of electricity, and weather manipulation to divert hurricanes and typhoons.

The future is bound to see large scale farming of the seas. The ocean floors will be ploughed by huge dredgers to increase their fertility and select forms of hybrid sea weeds will be grown on a large scale to be harvested by special combines. Under water lights and scents will attract large shoals of fishes which will be herded by bubble fences and sucked by pumps for processing in ships. Fresh water will be made available to people on land by new methods of desalination. One can even envisage gigantic sea platforms which will house marine factories engaged in the processing of food, chemicals, minerals and medicines obtained from the seas. One can reasonably expect that this rosy dream will become a reality in the not-too-distant future.

Tidal and geo Thermal power plants have been in use only to a very limited extent. Prospects of economic power generation from these sources are, for the present, negligible. Research on direct conversion of tidal force into electricity is being carried out in many parts of the world.

Until recently, mining outside the coasts was limited. But the present and most predictable interest in the continental shelf is in its petroleum potentialities. Wallace E. Pratt has pointed out that the greatest areas of petroleum production and reserves on land are in the landward portion of the vast plain intervening between the continental heights and the oceanic basins proper, in particular in three of the four great Mediterranean regions,[1] within which lies

1. Pratt, World Geog. of Petroleum, Amer. Geog. Soc. Special Pub. No. 31, 1950.

more than 50 percent of the 11,000,000 square miles or 28600000 km^2 of the total continental–shelf area of the earth. He observes that geologically the "peripheries of the continents......(Constitute) a fundamentally superior environment for the generation and accumulation of petroleum".[1] It is now believed that a significant part of the total production of petroleums may eventually come from the continental shelf. But the difficulties and the great expense of operations in storm-swept water several hundred metres deep make profitable exploitation in the deepest waters of the continental shelf seem improbable.

1. Op. cit., p. 325.

CHAPTER 8

INLAND WATER RESOURCES

Rivers, lakes, canals, swamps constitute the inland water resources of the earth. Rivers have a definite relation to man, though it varies from place to place and from time to time. Rivers are more than conduits for water of a certain length, width, depth and speed, for consumption, irrigation, power or navigation. Along most of their courses they are hindrances to local cross-country movements, and sometimes they from effective international barriers.

Ecological Considerations

Water ranks at or very near the top in any listing of the world's most essential, valuable and precious and natural gift; for without it there could be no life. Moreover, with the exception of air, water is the cheapest necessity. According to Brunhes water is everywhere the sovereign ruler of human activity. In addition to its major significance as a source of water supply, inland water exercises considerable influence over the cultural landscape. Among the items affected are irrigation and land utilization, distribution of population, water-power development and routes of travel.

Irrigation

The greatest development in the history of mankind was the discovery of agriculture and then came irrigation. Irrigation is the artificial application of water to crops, without which they would perish. Artificial watering or irrigation, is the principal method of plant conquest in all arid, semi-arid and desert lands. According to archeologists, the earliest records of man show that civilization grew and prospered in lands along the banks of irrigation canals. The history of Egypt shows a similar effect of the yearly inundation of the Nile valley. Here, as in all rainless countries where irrigation must be practised, the water becomes a potent factor of political union and civilization. The fact that the earliest civilizations have originated in the sub-tropical rainless districts of the world has been ascribed solely to the regular and abundant returns to tillage under irrigation, as opposed to the uncertain crops under variable meteorological conditions, to the consequent accumulation of wealth, and the emancipation of man for other and higher activities, which follows his escape from the agricultural vicissitudes of an uncertain climate. When Draper says : "civilization depends on climate and agriculture," and "the civilization of Egypt depended for its commencement on the sameness and stability of the African climate," and again. "agriculture is certain

in Egypt and there man first become civilized," he seizes upon the conspicuous fact of a stable food supply as the basis of progress, failing to delect those polent underlying social effects of the inundations—social and political union to secure the most effective distribution of the Nile's blessings and to augment by human devices the area acessible to them, the development of an intelligent water economy, which ultimately produced a long series of intellectual achievements.

Irrigation serves a dual purpose in world agricultural economy —firstly, they provide protection to crops against destruction and damage by failure of rain and secondly, they increase the yield of crops even in normal years.

In most of the countries, whose economy is predominantly agriculture, the need of artificial wastering of crops has always been felt, because the rainfall it gets is neither evenly distributed, nor is it regular or certain.

The poverty of the people and lack of irrigational facilities over certain parts of the world are obviously the reasons for this small proportion of irrigated area. Most of the irrigated area of the world lies in the greatest flat plains where facilities for irrigation are the greatest.

The outstanding feature of the rainfall of the world is its unequal distribution during the year and its variation from year to year in respect of quantity, incidence and duration. The average annual rainfall of the world is 999 millimetres, but it is only of the order of 200 millimetres is semiarid regions of the world, increasing gradually in subhumid areas until it is 1000 to 1500 mm. in humid regions. In Humid wet parts of the world, the mean annual precipitation is of the order of 1500 to 2000 millimetres a year, and in very wet region, the mean annual rainfall is of more than 2000 millimetres.

Apart from its unequal distribution in the year, the rainfall shows considerable variations from year to year. It is not uncommon in many places for rainfall in a year to be less than half the normal The concentration of practically the whole of the rain in a few months such as in monsoon lands, leaving the rest of the year dry. Most of themonsoon rains, however, occursduring thefour months of June-September, when many rivers are often in spate. On the other hand about 11 percent of the area of the earth gets less than 1000 millimetres rainfall a year, necessitating irrigation measures.

Rainfall of the world is, as already mentioned, unequal and in many areas uncertain. The distribution is as follows :

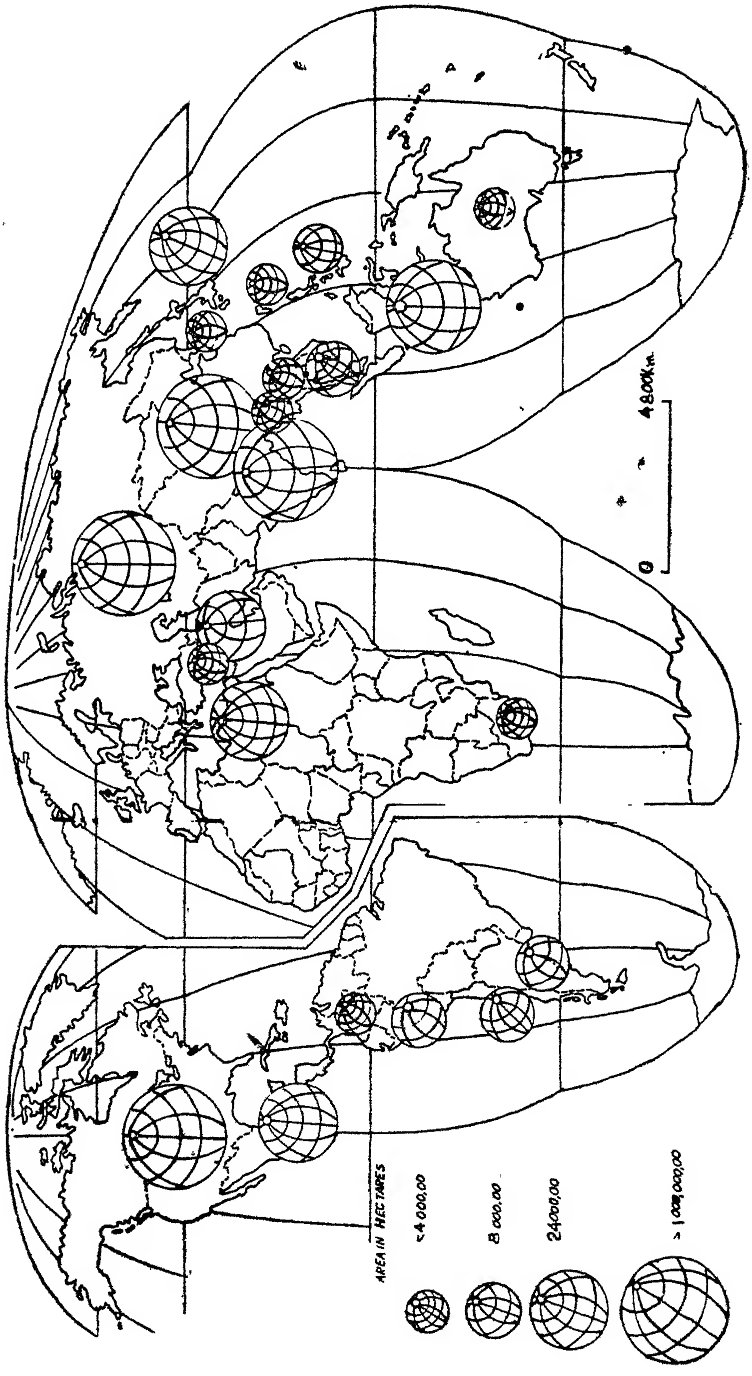

Fig. 8 1. Irrigated Areas in Selected Countries

Table 8·1

Land Areas of the Earth in Relation to Precipitation[1]

Region	Annual Precipitation (in millimetres)	Percent of Land area
Arid	Less than 250	25
Semi arid	250 to 500	30
Sub humid	500 to 1000	20
Humid	1000 to 1500	11
Humid wet	1500 to 2000	9
Very wet	More than 2000	5
	Total	100

Both groundwater and surface water are used for irrigation. Groundwater is especially used in the forms of tube-well and well irrigation in many parts of the world.

The well may be said to be the indigenous form of irrigation on the earth. It is very well suited to the poor farmer, because it is cheap to build, requires no elaborate machinery to work it, and does not need any specialised engineering skill to build it or to work it. It can be dug at the very door of the farmer, if necessary. Well digging needs no elaborate survey of levels as is necessary for canal construction. A simple "kachcha" well costs very little in most of the countries, and is, therefore, within the means of the poorest of farmers.

Apart from this economic consideration, well irrigation is suited to a large part of the world on geographical consideration also. The geological formation of Australia, for instance, is too simple to provide opportunities for 'artesian wells' where the pressure of water underneath is so great that it comes to the surface automatically. In some localities where the clay beds are thick enough, much larger supplies become available in the well by boring a hole (tube well) through the clay than are possible in the ordinary 'spring well.'

Well irrigation in the world is limited by—

(*a*) Water level is too low in certain areas. This is particularly found in the neighbourhood of rivers. But no generalisations are possible with regard to the water table of the earth as the subject has not yet been studied. Those countries in which the rainfall is very heavy usually have a high water table and water is very near the surface. In other countries, where rainfall is limited water table is low and the wells have to be very deep.

1. G. D. Clyde, irrigation in the United States, Amer. Soc. of Civil Engineers, Transactions, 118 : 312, 1953.

(*b*) The second limitation is the brackishness of the well water. Brackish water is useless for irrigation as it destroys the crop. No data are available in this respect also ; but it appears that brackish water may appear anywhere, even in a locality where other wells are sweet.

(*c*) The third limitation is that a large number of ordinary wells dry up during periods of drought when their water is needed most. They also mostly dry-up after a few hour's excessive lifting of water and are, therefore, unable to irrigate large area.

The tube-well are expensive to build, and to be effective, need machine power to lift large quantities of water. For successful tube-well irrigation are needed :

(*a*) the area must be in alluvial formations where water bearing strata at various depths are found ;

(*b*) cheap power for lifting water must be available ;

(*c*) the soil should be of good quality so that high costs involved in the operation of tube-wells are compensated by large produce.

The average discharge of a well may be taken as 30,000 gallons per hour and with this supply 2 hectares will be irrigated in 24 hours with a field water depth of 100 millimetres. In monsoon region, water of one tube-well usually commands an area of about 800 hectares, irrigating about 700 hectares annually, *i.e.* 600 hectares of sugarcane and kharif and 100 hectares of rabi. To irrigate and 'mature' this area the well should run 3200 hours annually.

Sub-artesian tube-wells are those in which water requires pumping, sub-artesian water is generally obtainable between 75 metres below surface, while for artesian flow, boring requires to be carried down to between 182 and 304 metres below the surface.

Tube well and artesian irrigation is also found in Australia, and some parts of Quetta valley in Pakistan, and French province of Artois where these wells were first understood. In India no typical cases of artesian wells for fresh water are worth quoting. There are many places both in India and other countries where underground water in a porous stratum rises to a considerable height in a bore tube but does not flow out; such cases are best referred to as Sub-artesian.

Canals : Many of the world's outstanding irrigation projects depend upon surface streams which have their origin in mountains. These streams are mostly used in canal irrigation. The canals are of two classes :—

(*a*) Inundation canals; and

(*b*) Perennial canals.

The inundation canals are taken out from rivers without building any kind of weir at their head to regulate the flow of the river and the canal. Whenever the river is in flood, water passes into

these canals. As soon as floods subside rivers fall below the level of the canal heads and these canals dry up. The greatest defect of these canals is that their water supply is very uncertain. They provide irrigation mostly during the rainy season when alone the rivers are mostly in flood. During the dry period when irrigation is needed most, these canals are useless. The larger number of inundation canals is in the Sub-humid or Semiarid regions. Owing to the uncertainty of water supply, most of the inundation canals are being converted into perennial canals with the help of the development of the large irrigation schemes.

The Perennial canals irrigate only about one-lenth of the total cultivated area of the world. The largest hectrage irrigated in Communist China where about one-sixth of the total cultivated area is irrigated by canals. The real importance of irrigation in India is that of the perennial canals, about 8000 kilometres. This length is so great that it completely encircles the earth at the Equator twice. Such stupendous irrigation works have never been known in the history of the world before.

India occupies the second most important place after Communist China, in the whole world. Roughly, about one-third of the total irrigation area of the world lies in India. Some of the largest canal systems of the world are found here. All this is because nature has endowed India with certain advantages that are seldom to be met with in other parts of the world on such a large scale.

In spite of it, India is not able to satisfy her entire demand for irrigation. It is only a small fraction of her total cultivated area that gets irrigation. Only about one-half of the total cultivated area in India is being irrigated. The net area under irrigation in India during 1965–66 and 1967–68 was 26·691 and 27·514 million hectares and the gross area 31·171 and 32 693 million hectares respectively. Net area sown in 1965–66 and 1967–68 was 136·135 and 137·03 million hectares respectively. The irrigated potential has gone up from 22·4 million hectares in 1948 to 75 million hectares in 1970–71.

The percentage of irrigated area to the total land area varies greatly in different parts of the world depending mainly upon physical conditions of climate, topography and soils. The monsoon lands and the humid lands of south eastern Asia record the highest percentage (73%) of the world's irrigated lands. Here, it is the demands of particular crops, primarily rice, which account for such heavy water consumption.

The United States does not rank with India and China in hectrage devoted to irrigation, but it does have some 33 million acres or 13,200,000 hectares under the ditch, and the largest single use of water is for irrigation—from 75 to 100 billion gallons per day, or approximately half of the fresh water used. California leads the nation in irrigation, with more than 2·8 million hectares devoted to it. more than 90 percent of all the water consumed within California state is for irrigation.

The total area under irrigation of the world is 109 million hectares. Nearly 27% of the total irrigated area of the world lies in Communist China, about 19% in India, 9·9% in U.S.A. and 8·6% in Soviet Union, while 7·9% in Pakistan, 4% in Indonesia, 2% each in Japan, Egypt, Mexico and Sudan. In Syria, the extreme case, it covers only 0·4% of the total irrigated land of the world. The same is the case with Colombia, Burma and Republic of South Africa, that is 0·3% of the total irrigated land of the world. Fig. 8·1 shows the irrigated areas of the world.

The table 8·2 shows the percentage of total irrigated area of the world. Countries irrigating more than four lakhs hectares annually for one nonspecified year, 1960–69.

Table 8·2

Percentage of total irrigated land of the world.[2]

Country	Total % of the world
Communist China	27·0
India	19·0
United States	9·9
Soviet Union	8·6
Pakistan	7·9
Indonesia	4·0
Iraq	3·4
Japan	2·3
Egypt	2·1
Mexico	2·0
Sudan	2·0
Turkey	1·4
Spain	1·3
Iran	1·2
Argentina	1·2
Thailand	1·1
Chile	1·0
Peru	1·0
Philippines	0·7
Australia	0·4
Laos	0·4
Syria	0·4
Burma	0·3
Republic of South Africa	0·3
South Korea	0·4
Colombia	0·3
Nationalist China (Taiwan)	0·4
Total	100 0

2. Based on Production year book, F A O. 12 : 8—9. Data for the total percentage were computed by the author.

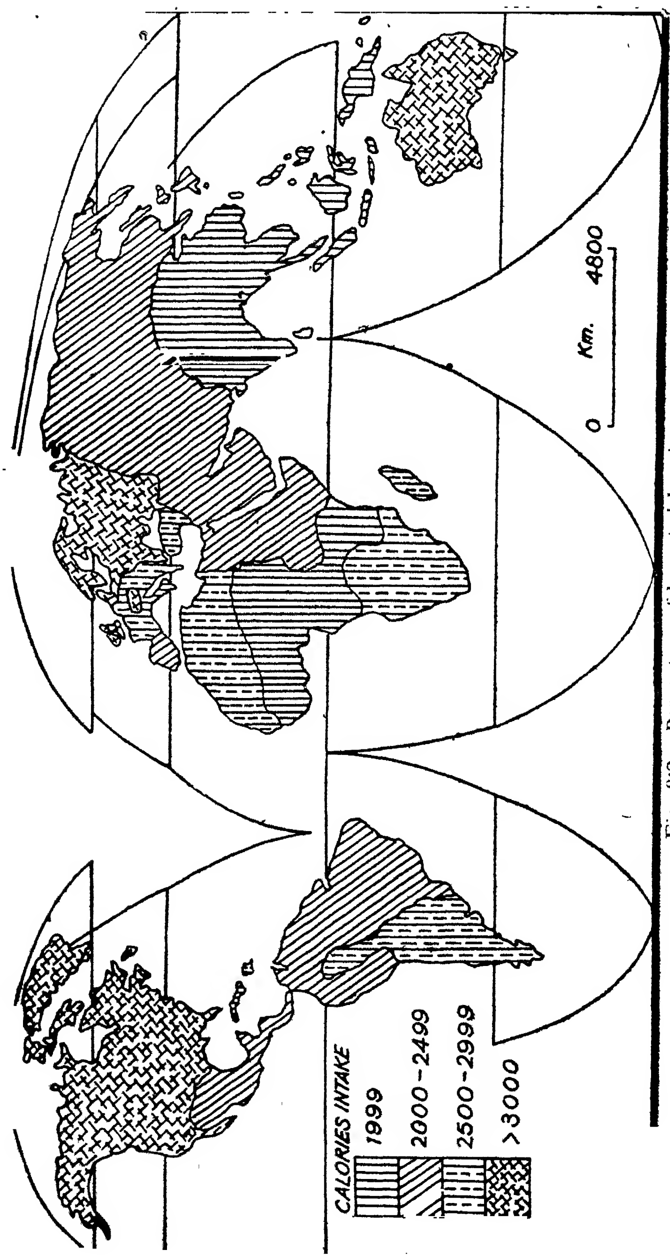

Fig. 8·2. Percentage of Irrigated Land

Among the countries of the world, China, India and the United States lead in the number of hectarage irrigated. In American west, except for the Pacific Northwest, there could be little agriculture without irrigation. More recently hydroelectric power has become irrigation's "partner", but also a subtle competitor along with other water uses within the multiple use concept. It is power that will pay much of the reimbursement costs of the multiple-purpose projects—within this frame of reference, irrigation benefits. On the other hand and within the same context, irrigation becomes only one of many uses, including power, flood-control, navigation, Salinity control, Sanitation, recreation, sedimentation control, municipal and industrial water, fish and wild life. The effect of the Cloumbia Basin Irrigation project, for example, will be to close most of the population gap across the desert part of the northern Columbia Plateau from the Cascades east to the vicinity of the fertile Palouse of eastern most Washington ; the Columbia will then have created a band of population comparable to that of the Nile in effect, however different in shape and engineering development.

The greatest changes in the use of the rivers are associated with the development of irrigation. Extensive irrigation on Indo-Ganga Plain, for example, dates-back from medieval period. Before that time most of the plain was empty. But mention of irrigation works is made in the *Vedas*, *Puranas* and other epics.

Irrigation projects indicate still more changes in the future, the most important of which is the reclamation of about million hectares of the Chambal bad lands by the use of water from the Chambal irrigation project.

Development of Water Power

In the cultural evolution of man he has striven to gain mastery over his environment, and in a large measure his achievements reflect an increasing use of water power. Water is a permanent and perpetual source of power. In the words of Smith, "Coal and oil and gas in time will go, but water power will remain. As long as the rains and snows from heaven fall upon this earth, as long as water runs down to sea to be lifted by the sun through evaporation and wafted over the lands to start its journey a new, man will have at his disposal a perpetual source of power."[1] Four fold increased in electricity was recorded during 1951 to 1972, which is clear from table 8·3.

1. Smith, Smith and Phillips, Industrial and Commercial Geography, p 328, 1955.

Table 8·3
Development of electricity[1]
Figures in billion Kwh.

Continent	1953	1960	1968	1972
North America	595	979	1653	2156
South America	26	51	90	126
Asia	85	227	463	735
Europe	387	682	1214	1585
Oceania	16	38	59	84
U. S. S. R.	134	293	639	857
Africa	21	39	74	103
World	1,264	2,304	4,192	5,646

The magnitude of the change in the source of energy during the last hundred years is shown by the following table 8·4.

Table 8·4
Percentage of energy derived from various means.

Source of Energy	1850	1950	1974 (est.)
Total, Specified sources	100·0	100·0	100 0
Mineral fuels and water power	5·8	94·0	96·0
Work animals	78·8	3·0	1·0
Human	15·4	3·0	3·0

River Highways as basis of Commercial pre-eminence

"The importance of inland waterways for local and foreign trade and intercourse has everywhere been recognised" according to Miss Semple, or "throughout the civiliz ed world, the largest cities and the denset populations, and the greatest development of industry and commerce are to be found where streams and lakes enter into the landscape," according to Smith.

From many points of view, the inland water ways of the world are the most important means of transport. The main feature of the river communication is that they especially join the sea-port. The most important of the sea-ports on which the foreign commerce of the country concentrated, later became important industrial centres which necessitated a further development of communications between these ports and the inland towns, for their market as well as the source of material lay in the hinterland.

From ancient times, the trade and commerce has been facilitated by the abundance of navigable streams and the flat topography of the countries, History records evidence of a flourishing trade carried along the rivers and canals from the earliest

1. Various Sources.

times. In many countries of the world, such as in India, the importance of waterways gradually diminished with the development of the railways with the result that the steamer service was gradually with drawn and country boat traffic also decreased.

India is a land of many rivers, and yet water transport has not made much headway in this country. There are many weaknesses.

1. During the rainy season the rivers are in high floods and consequently have a strong current which is not easy to navigate.

2. During dry seasons, only the big rivers have water throughout their course, others become disconnected pools in which navigation is impossible.

3. Even in the large rivers, during dry seasons, water is very shallow and there are sandbars due to silting which further reduce the depth of the water.

4. Indian rivers usually enter the sea in shallow, sandy delta-mouths, instead of broad and deep esturies, which in western countries offer a pathway for ships far into the interior.

The length of navigable waterways in India is about 14000 km. of which 3500 km. are navigable by steamers. Important among them are the Ganga, the Brahamputra and their tributaries, the Godavari, the Krishna and their canals, the backwaters of the west coast canals of Kerala, the Buckingham canal in Andhra Pradesh and Tamil Nadu, the Delta canals in Orissa and the Mandovi and the Zuari at Goa.

In Lower Bengal, Assam and in the river deltas on the east coast however, there is enough water in the rivers and navigation is possible throughout the year. These regions are not well supplied with railways or roads. This fact naturally makes navigation the only efficient means of communication. On the Ganga in Bengal and Bihar and on the Brahamputra in Assam a large number of steamers, apart from the small country boats, ply to cope with the large amount of traffic that is diverted to the rivers. The size of these steamers is limited by the minimum depth available during the dry season. For about 600 kilometres from its mouth, Ganga maintains a nearly uniform depth of about 15 metres and so steamers can safely move upto the distance, although country boats proceed as far as Hardwar.

Ocean-going steamers come upto Calcutta on the Hooghly with the help of continuous dredging.

The Brahamputra is navigable by steamers throughout the year and steamers run from its mouth to Tezpur and occasionally to Dibrugarh. It carries Assam oil, tea, timber and jute which are brought to Calcutta. Though a number of rivers are found in Deccan yet owing to their rock surface, they are navigable only in their lower courses and that too during the rainy season, when their is enough water in them. Narmada, Mahanadi, Krishna and Kauvery are such rivers.

The Ganga-Brahmaputra Water Transport Board (1952) has been set up by the Government with the responsibility of improving the Ganga-Brahamputra river system for navigation and to extend it as far as possible. This Board will coordinate and stimulate the navigational activities of the states of U P , Bihar, Assam and West Bengal situated on this river system. Under this Board, plans are now afoot for starting a pilot project with upto date craft for towing barges on the shallow stretches of upper Ganga between Patna and Allahabad.

In Europe, the Danube and the Rhine are of great human significance. Both are navigable over long distances; together they form a natural passage-way from west to East Europe. They are connected by a canal from Bamberg on the Main, a tributary of the Rhine, to Regenberg on the Regen; a tributary of Danube, but it is little used. A proposal to construct a large canal which would allow barges of 1500 tons to pass without break of bulk from the North sea to the Black sea has been shelved because of ideological differences between eastern and western European countries. In their own basins, however, both the Rhine and Danube are of outstanding importance as commercial routes.

Rhine as a Highway of Commerce

The Alpine snows are like giant reservoirs, and give birth to such important rivers as the Rhine Po, Rhone and many tributaries of the Danube. The khine, at Basle bends abruptly to the north, and enters a plain. This plain extends to Mainz, and is about 288 km. long and 32 km. broad. It is covered with a rich alluvial soil, which, combined with the hot summer climate, renders the area extremely productive, and wheat hops, tobacco, and friut-trees are grown. The plain is flankee by the vosges on the west and the Black Forest on the east. These mountains have rounded summits, and for the most part are covered with pine-forests. A great deal of timber is cut in the Black Forest, and formed into rafts, which are floated down the Rhine to be used in other districts or exported at the mouth. The peasants in the Black Forest are skilful in wood-carving, and their cuckoo-clocks are famous.

The total length of Rhine is about 1120 km. of which 704 km. navigable and other 176 km. in Netherlands. Its main tributaries are Lippe, Ruhr, Lahn, Moselle, Main, all have navigable are some of them of considerable length and capable of carrying barge loads of about 1000 tons.

Many important industrial towns lie in the Rhine highway. Mulhouse (110,735) and other places at the base of the vosges utilize the water power there available for manufacturing cotton goods. Strasbourg has a position of great strategic and commercial importance on the Ill tributary of the Rhine, opposite the Zabern pass over the vosges. Mannheim (339,300) is a busy port at the mouth of the Neckar, for very large barges can ascend to this point. Mainz (146,200), as it is often spelt, stands at the confluence of the Main.

Between Mainz and Born the Rhine flows through a deep gorge which it has cut across the Rhine Highlands. The lower course of the Rhine its across the plains of North Germany and Holland. Cologne (koln) stands on the Rhine, somewhat below the beginning of the plain, and where the river can be conveniently crossed by the route from Paris which skirts the base of the Ardennes and Rhine Highlands. Sea-going vessels can reach this point, save in winter, when the river is frozen, so the town is a busy port. Below Cologne (859,830) the Ruhr enters the Rhine from the east. This passes through a rich coal-field, and as iron is found in the Highlands somewhat farther south, its basin has become a great manufacturing area. Iron goods are manufactured at Essen (729,657), north of the Ruhr, and at Dusseldorf (705,122), which is the Rhine porf for this region. The largest tonnage moves along the stretch downstream from the Ruhr; navigable for ocean vessels carrying up to 400 tons, although most of the traffic is in barges of 2000 to 3000 tons capacity.

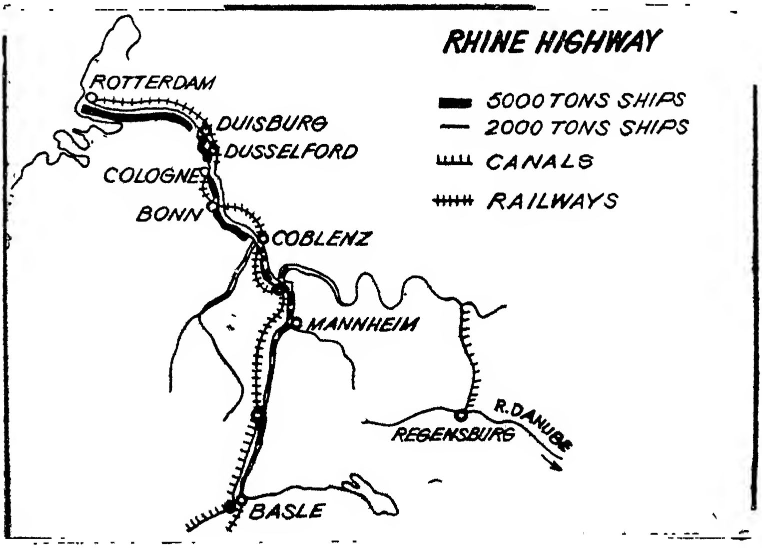

Fig. 8 4. Rhine High way

The downstream movement of coal, fertilizer chemicals and steel and the inbound movement of iron, ore, grain, and petroleum gives Rotterdam, the major Rhine mouth port, a heavier transit trade than any other seaport in the world. "Rotherdan became the main entrance and exit for the whole of western Europe. The city has important ship-building, chemical and oil refining industries, but its chief function is as an entrepot (warehouse) port, whence goods brought by ocean-going vessels are carried by inland shipping along the rivers and canals, and vice versa. Each year more than

20,000 ocean-going ships and 200,000 inland vessels exchange their cargoès. Rotherdam as a harbour is still growing."[1]

The Danube as a Highway of Commerce

The Danube rises in the Black forest, and than crosses a plateau which lies partly in Germany and partly in Austria. It becomes navigable for small boats not very far from its source, and rapidly increases in size on account of the many tributaries it receives from Alpineland.

Vienna (1,636,600) the capital of Austria, stands on the Danube just below the point where the river descends from the plateau of its upper course, and before it passes between Alpineland and the Little carpathians to enter the Plain of Hungary. Some way east of Vienna the Danube turns sharply southward across the Plain of Hungary, which is enclosed by the Carpathian Mountains on the north and east. The Theiss and Pruth tributaries of the Danube rise about the middle of the range, but flow in opposite directions. This plain is most productive and large areas of it are devoted to growing wheat, maize, and Sugar-beet. The Danube enters this plain through the Iron Gates, the name given to gorges between the Carpathians and the Balkans, where the river forms rapids, and where a canal has had to be cut to avoid them. The delta of the Danube is crossed by many channels, and is marshy and unhealthy. For 48 km. in an easterly direction from Galatz, the Danube flows in a single channel until it breaks into several branches of its delta. The most important of them from north to south are : Kilia, Sulina and St. George. The mean annual outflow of all these is estimated at 315,200 cubic metre per second, and the amount of silt brought down at 108,000,000 tons per year.

The Delta of Danube is about 2600 km², which is silt laden distributaries of the river slowly meander. Before engineering works were started to make the channels navigable, ships drawing only 3 metres of water experienced great difficulty in entering. By 1950 ships drawing 10 metres of water could reach Braila. Below Regensburg (Ratisbon) it becomes navigable for 100 tons craft Sea-going vessels having a register less than 4000 tons can ascend upto Braila (138,857), but those of less than 600 tons can sail as far as Tournu Severin. Wheat and maize are exported from ports near the mouth of the river. The chief exports from Rumania are cereals and flour, timber, petroleum and most of Russian goods.

Before World War II, the administration of Danube was controlled by a single European Commission of the Danube according the treaty of Paris in 1854. Its headquarter was Galatz (151,349) and it administered Danube delta only. Beyond Braila it had no jurisdiction, although it encouraged improvements in the Hungarian section of the river. The commission was re formed in 1921 by Great Britain, France, Italy and Rumania, but again it concerned itself only with free entry into and navigation on the river.

1. J. J Branigan, Europe, pp 164-165, 1971

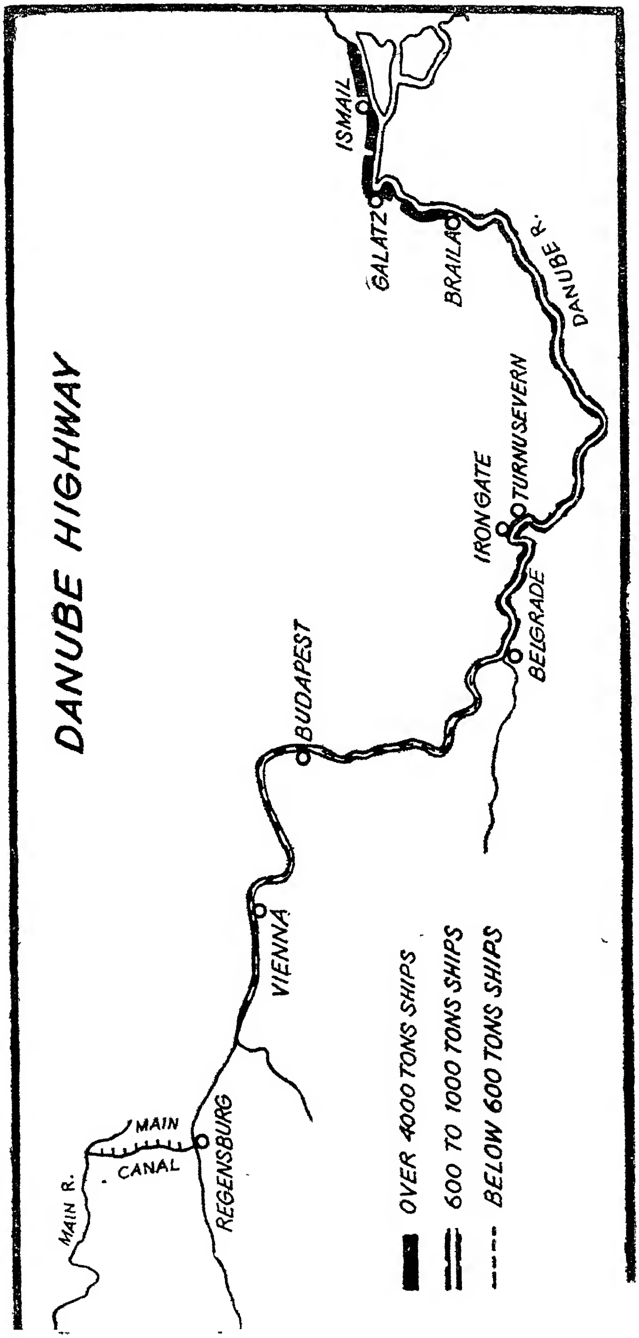

Fig. 8·5. Danube Highway

In 1948, a completely new commission included only the countries along the Danube—Great Britain, France and Italy being excluded. Since 1948 the Russians have controlled shipping on the Danube but the river is still international in name and navigation on the Danube shall be free from open for the east European nationals, vessels of commerce, and goods of all eastern States, on a footing of equality in regard to port and navigation charges and conditions for merchant shipping.

Among the present utilizations navigation takes the first place. During the last years it was considerably extended and its structure was characteristically altered from the transport of raw material to the transport of semi-manufactured and finished products. The production of electrical power from hydro-electric power stations on the Danube is hitherto of importance only at the headwaters, but after the initations of the power station at the Iron Gate a fundamental change will take place. Danube fishery is still important, whereas the utilization of the river water for purposes of irrigation still has essential possibilities of extension.

Kiel Canal—Kiel Canal was constructed in 1887-95 and widened and deepened 1907–14 to provide a quicker and safer passage from the North to the Baltic seas than by going round Jutland. It connects the Baltic Sea with the North Sea and runs across the South of Jutland from Kiel (272,507) on the Baltic to the Cuxhaven on the mouth of the Elbe. The Elbe enters the North sea by a long estuary, at the head of which is the great port of Hamburg (1,847,300), and the smaller one Altona. Hamburg occupies an unrivalled position for the export of goods from the basins of the Elbe and upper oder, and for direct trade with foreign lands is better situated than the Baltic ports, though vessels from the Baltic can now reach the North sea by the Kiel canal. By the Peace Treaty this canal is open to the ships of all nations at peace with Germany.

The Kiel canal is one of the most important navigable canal of the world and handled over 30 million tons per year. The main cargoes are timber and iron ore westwards, coal and mineral oil eastwards.

Navigable Rivers

The rivers of most use for navigation are the Mississippi and Missouri and the most important canals are the canal of St. Lawrence, which unites the Ontario and St. Lawrence; the Sault Sainte Marie canal, between Superior and Huron ; the canal which links the chesapeake to the Ohio; the New York canal; and the canals between North Allegheny and Erie.

The length of navigable waterways in United States is over 36072 km. The Mississippi river system, largest of all, provides more than 8000 kilometres of waterways with depths of 3 metres or more, including the main river trunkline from Minneapolis to the Gulf of Mexico-a distance of more than 12880 kilometres. The Missouri, a tributary of Mississippi, is navigable for 1216 kilometres to Sioux city, Iowa.

On the recommendations of The Ralph M. Parsons Company, a private engineering and construction enterprise with headquarters in Los Angeles, was set up under the project to carry out technical assessment of water and power potential of North America. The project is referred to by the company as NAWAPA—the North American Water and Power Alliance.

The basic idea behind 'NAWAPA is to capture the surplus waters of the Fraser, Yukon, Peace, and Athabaska river systems in north western North America and to direct, via an elaborate system of canals, reservoirs, and tunnels, the surplus water to deficit areas in Canada, the United States and north Mexico."[1]

The St. Lawrence Seaway

The St. Lawrence, with the great lakes, forms a very important commercial route into the heart of North America. The river is, however, ice-bound for about four months every year, and has various rapids and falls which have necessited the cutting of canals to enable sea-going vessels to reach Lake Superior. Large ocean vessels can pass about a thousand kilometres up the river to Montreal ; but here goods have to be transhipped to smaller vessels, are rapids occur, and the canals made to avoid them are not over 3·5 metres deep.

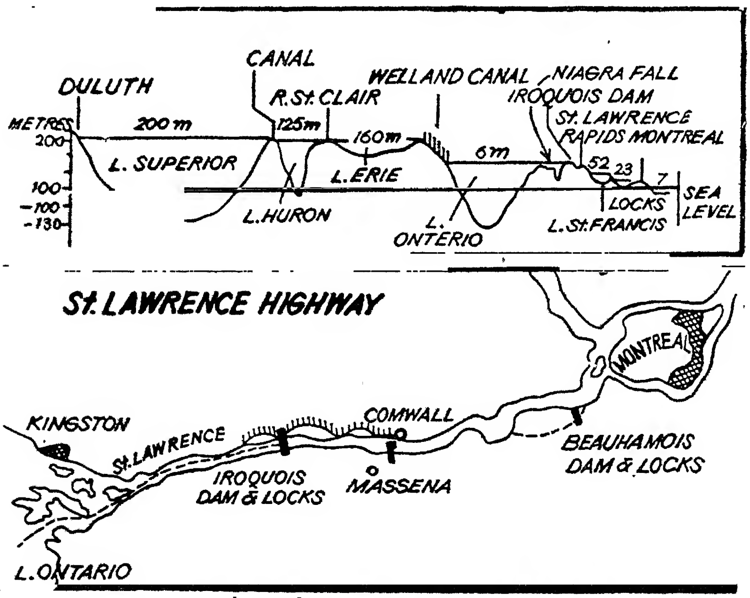

Fig. 8·6. St. Lawrence Highway.

1. H. Bowman Hawkes—Irrigation in the United States, chap. 6 in Conservation of Natural Resources, Edited by Guy-Harold Smith, 1969. Joh. Willey & Sons. New York.

The Canadian government built a 3·5 metres deep canal around the rapids that permitted shallow draft boats to negotiate the St. Lawrence between Lake Ontario and the sea. After the Welland canal and its eight locks were completed in 1931 interest in the Great Lakes–St. Lawrence Seaway was renewed. Fig. 8·6 shows the use of St. Lawrence water bodies.

World war II demonstrated the need for the St. Lawrence Seaway in the defense of Anglo-America. The availability of the hydroelectric energy was an incentive to improve navigation and develop the power resources simultaneously.

The St. Lawrence enters the ocean by a deep estuary due to submergence in the past, but navigation is rendered difficult by the prevalence of fogs and the rapidity of the current. The valley of the St. Lawrence is fertile, and the whole length is lined with villages and towns.

Another canal has been made to avoid the falls of Niagara, though a great deal of trade is diverted at Buffalo to the Erie canal and Mohawk-Hudson route to New York. The Sault Sainte Marie or 500 canals were necessitated by rapids between Lake Superior and Lake Huron, and the traffic on these canals is enormous. Besides these a canal has been cut between Lake Ontario and Georgian bay, Lake Huron, but only about 3 metres deep, and it is also proposed to cut a canal from Georgian Bay to the Ottawa river.

Water as a Industrial Resource

The location of industrial plants is dependent on an ample water supply of suitable quality. Information relating to the chemical characteristics of the water supplies is not only essential to the location of many plants but also is an aid in the manufacture and distribution of many commodities. Numerous types of manufactures require large quantities of water in their industrial processes other than the water consumed by the employees of the plants. Thus the amount, the quality, and the cost of water are important factors of industrial location for some types of manufacturing. An abundant supply of water is a necessary prerequisite for any steel producing unit. A broad idea of this requirement can be had from the fact that, at Rourkela, nearly 25 million gallons of water a day is needed for cooling purposes and for the scrubbing of gases alone.

The Steel industries are tremendous users of water. The site of the Jamshedpur works has been selected in a narrow valley formed by the river Subarnarekha and the Khorkai rivers in the district of Singhbhum in Bihar. These two rivers, the Subarnarekha and the Khorkai supply the works with water. These rivers are irregular in flow and almost dry up during summer. The water is, therefore, pumped from the Khorkai, which is nearer the works, and stored in a tank.

The technical literature on European steel, chemical, petroleum

and paper manufacturing[1] and Ackerman and Lof's summary of American experience seem to support the same point. The materials marshaled by C. Langdon White in his study of the iron and steel industry[2] might be interpreted as supporting the same argument. He shows that the Fontana plant in Southern California, in an area where water is relatively expensive, uses 1400 gallons per ton of finished steel at a cost of 2 cents per 1000 gallons. But the Fairless plant on the Delaware River, in an area where water is relatively cheap and available, uses about 37,000 gallons per ton[3] at a cost of 0·9 cent per 1000 gallons. White[4] concludes that "when once the problems of assembling Coking coal, iron, ore and limestone at the blast furnaces and of supplying markets with steel have been solved, the availability of a huge supply of water of good quality and at reasonable cost becomes a major location factor." Water use per United States ton of Crude steel was found to range from 871 to 66,834 gallons.

Iron and steel mills are the largest industrial users of this resource : without huge quantities of clean, cool, and inexpensive water this invaluable industry would come to a complete half, paralyzing the national economy.

Gilbert F. White, a leading authority on water among geographers, says : In recent decades one of the crucial developments in the whole field of water resources has been the relatively rapid increase in use of water for manufacturing and its increasingly strong claims for water in competition with other uses.

Gibson's[5] studing of the paper industry of north western England notes a range in intake of water per ton of production from 3150 gallons to more than 400,000. He shows the relation of location of both water supply and waste disposal to plat location and roughly assesses the effect on water intake of plant size, raw materials used, quality of paper product, and amount of recicula-tion.

Sporch, from his studies of industrial location in Belgium, concludes that water is a factor of importance but that changes in the technology of water and energy use are permitting industry greater latitude in the choice of new locations within large area.

Geographers in Germany, Belgium and United Kingdom have called fresh attention to industrial water needs. Rapid

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1. D. J. Tow : Cooling water for Industry, Petroleum, Vol. 19, 1956 pp 233—236

2. C L. White : Water—A neglected Factor in the Geographical Literature of Iron and Steel Geog. Rev. Vol 47, 1957, pp. 463—489.

3. R. L. Leffler : Water and Steel : Fairless Works Water Supply, in water for Industry, pp. 35—42

4. White, op. cit. p 468.

5. J. R. Gibson—Influence of Water Supply and effluent disposal upon location—Paper making and Birtish paper Trade Jour. Vol. 136, No. 4, 1958, pp. 64—66.

expansion of manufacturing capacity in some industrialized countries, introduction of industry into new areas, and heavier competition for water sources from growing cities and supplemental irrigation enterprises have combined to point the increasing importance of industrial use as an aspect of water economy.

Development of Pisciculture

The aquatic resources of Inland waterways are varied and abundant. The bulk of the existing culturable inland water area consists of river, tanks, lakes and ponds etc. Carp, which are the fish most frequently reared in Indian waters, for instance ; do not spawn in impounded waters with the result that stocking operations in the same water have to be carried on year after year. In the artificial spawning of carp could be developed or alternatively such species of fish located as would spawn in impounded waters and would be otherwise suitable for stocking, the industry could be improved considerably. The artificial spawning of species of fish that do not normally breed in enclosed waters has been successfully achieved in Brazil, and in Indonesia common carp from Europe are made to spawn three to four times in a year by special methods.

The extensive areas of Ganga system, Brahmaputra, Mahanadi, Krishna, Mississippi, Volga, Rhine, Danube, Hwang-ho, Nile etc. are the main areas for inland fisheries. Inland fishes are grouped under cat fishes, carps, Prawns, Eels, Anchoveta etc. Though several kinds of edible fish are obtained from fresh water sources, only a fraction of the inland water area is devoted to planned pisciculture.

India has also a good supply of fish in her rivers. But the industry is not carried on scientifically. Except Bangladesh and Bengal private enterprise is lacking mainly on account of caste prejudice.

In Burma, the government has monopolised it. The fisheris yield a substantial revenue to the state and therefore, they are a very important source of national wealth. Open lakes, pools of water , and small rivers are leased by the Government to the highest bidder at public auction. The Irravadi division is the most important fish supplier. Thousands of men are engaged in this industry. Religious restrictions do not allow the Buddhists to fishing as it involves the taking of life, but some of them use as food material.

MANS RELATION TO INLAND WATER RESOURCES

The River as a Boundary

According to Semple[1] "They (rivers) are convenient lines of demarcation and strategic lines of defense......Poor as a scientific boundary, a river is not satisfactory even as a line of demarcation, because of its tendency to shift its bed in every level stretch of its course." Rivers may serve as lines of demarcation and therefore fix frontiers, but they can never take the place of scientific bound-

1. Semple, op cit. pp. 362—363, 1911.

aries. "Boundary is not a line, but a zone of considerable and variable width, enclosing the line on either side with a marginal belt of mixed character".

The Indo-Nepal boundary in the Kali or Sarda valley in "Himalaya-west" crosses the river in a broad transitional zone of mingled people and speech in and above the Hill-town of Pithoragarh. The Indo-Nepal linguistic frontier in Himalayan borderland crosses the Kali valley just above Tanakpur, but the whole U. P. Himalayan region above the Lesser Himalayan region in U. P. shows fundamental ethnic unity, indicated by identity of head form, stature and colouring.

River Jamuna forms a well maintained linguistic boundary between western U.P. and Punjab, except in the northwest corner of U. P., where the hill state between the Tons and the Nahan has enticed a small group of Himachali across to the southern side.

River and Population

Rivers are of great importance to man. River deposits make fertile, level land and are often the seat of a dense agricultural population. The river water is useful for navigation, for watering desert lands by irrigation, as a water supply for many purposes, as a source of water power, as the home of valuable food fish, and for other purposes. In these and other ways rivers are closely linked with the past history of mankind, and with its present life and pursuits.

The evenly graded surfaces of large alluvial fans are frequently excellant farm land, and in arid regions they are very often irrigated. When drained, however, such land often makes excellent farm land, for the surface is level, and the abundant humus in the alluvium deposit favours the growth of many crops.

River and Civilization

It was no mere accident that some of the oldest human civilizations of ancient past had their origin in river valleys. In such valleys as those of the Nile, Euphrates, and Indus, natural barriers of the desert and thin pasture gave some protection against invaders. Ancient Rome grew up on both banks of the Tiber, and extended her commercial and political supremacy up and down stream. The Babylonian civilization is originated in Euphrates and Tigris valley. The culture of the valley originated in Lower Indus, and with that easy transmissibility which characterizes ideas, it moved upstream into Present Pakistan, which never evolved a culture of its own. The present culture of Pakistan is different from the culture of Indus valley civilization. Just as noticeable is the political interplay. The rule of the Mohammedans extended far east of the Indus, at times to the thirteen century, and at one period Mohammedan kings extended their sway over Bijapur and Golkunda. It is doubtful whether the Mohammedan conquest and the establishment of the Muslim Empire had any very considerable effect upon original civilization of India.

Towns and cities develop along the larger valleys, often at the junction of tributaries along which other routes extend, making the the junction of the valleys a centre of converging highways.

ECOLOGICAL CONSIDERATION OF RIVER BASIN PLANNING

The relation of rivers to the occupation of the land by man is intimate and fundamental in importance. A river is a natural drainage line on the land. There is an ever-increasing need in the world to know more about water and its behaviour. The demand for water the world over since the last war has been stupendous with nations spending fabulous funds on hydel projects, canals, wells and pipelines. There is hardly any modern country whose river basins are not cross hatched with dams, laced with power-lines and irrigation reservoir and channels. But despite all these "modern pyramids", the Tennessee valley Authority, the Aswan High Dam, the Nagal-Bhakra Dam, D.V.C., men's thirst remains unquenched.

Again, water has been a bone of contention between individuals and between nations. There are inter-state river-disputes not only in India but also in the United States where the Supreme Court had to settle a long standing feud between Arizona and California over use of the waters of the Colorado river. The California master water Plan served to demonstrate that full satisfaction of the ultimate water requirements of all parts of the State was physically possible of accomplishment. The plan envisaged about 376 reservoirs throughout the State with a total gross storage capacity of about 117,363 million square metres to be added to the 32,536 million square metres of capacity of the then existing reservoir. Construction of all the features of the California Water Plan will be accomplished over a long period of time. The full natural season run-off of streams in California amounts to 103,316 million square metres. The water needs of the state have been estimated to be of the order of 80940 million square metres.

River basins can be examined for the purpose of gaining a picture of their normal conditions, and in relation to these normals the eccentricities of drought and flood can be measured. The Irrigation Commission of India has rightly emphasised that "river basin plans must be prepared if the water resources of the country are to be developed to the best advantage" only recently has a master plan been prepared for development of the "Water Resources of the Narmada in Madhya Pradesh" and that too under the pressure of a water dispute being under adjudication by a Tribunal.

The commsssion has expressed the view that "carefully prepared and comprehensive plans, based on adequate data and studies, will minimise inter-state conflicts on the use of water". Such studies are to include the determination of waters which might be surplus to the requirements of certain river basins and could be utilised

elsewhere. When a surplus is established after preparation of basin plans, only then should any project for diversion of the surplus water to any other basin be initiated.

The Irrigation Commission of India suggests, "Basin plans should be formulated on the basis of feasibility studies for each individual project." Feasibility studies may not be possible in case of all possible projects on a river system due to non–availability of adequate hydrological data and inadequacy of topographic surveys. Notwithstanding this, it is important to prepare a master plan on the basis of available data, rather than wait for collection of all the comprehensive data usually required for feasibility studies.

Mr. Wiemnen, a former Director General Water Planning for Israel, who suggested, "A master plan should be drawn up at the very beginning. The plan should include tentative stock-taking of resources, demand estimates with indications of priorities, a preliminary allocation of supplies and a first outline of physical planning, staging and scheduling. In order to satisfy the immediate needs of expanding economics, the master plan should also include detailed proposals for early implementation of high priority projects Further more the plan should outline a programme of research, investigation and data collection as required for the subsequent stages". The river basin plan should, therefore, be reviewed from time to time, modified and brought up to date. This should be a continuing process.

The necessity for preparation of master plans for integrated water utilization in India is essential for the development of environmental or ecological improvement of river basin planning for the abiding prosperity of the country.

Ecological Consideration of Lakes

Lakes are of service to man in numerous ways :

1. The store water useful for—(*a*) regulating stream volume, (*b*) supplying water for city drinking supply, as at Nainital; (*c*) supplying water for factories, as in western Ghats especially in Lonavala, Walwan and Shirvata Lake: (*d*) furnishing water for irrigation and (*e*) generating water-power for industrial and domestic uses as from the Tata Hydro-electric works.

2. They are an important source of food fish.

3. As resorts, for health and pleasure, such as lakes of Kashmir valley and Kumaon Hills, lakes possess a high value to mankind.

4. The larger lakes are highways of navigation, especially well illustraled in the case of the Great lakes, one of the worlds busiest highways.

5. They have been a large factor in the location and growth of a number of large cities—Detroit on Erie, Chicago and Gary on

Lake Michigan, Duluth, Superior, Port Arthur and Port William on Lake Superior.

6. They may even be sought for protection of a water frontier—The margin of river, lake and sea, according to Semple has "always attracted the first settlements of man because it offered a ready food supply in its animal life and an easy highway for communication. Moreover, a water front made a comparatively safe frontier for a small, isolated communities......"[1].

7. Lakes exert a powerful influence upon local climate.

1. Semple, op cit. p, 318, 1911.

PART III

MINERAL RESOURCES

CHAPTER 9

MINERAL RESOURCES

The mineral resources of the world means the appropriable gifts of nature which can be used for satisfying human wants. They include iron, copper, lead, silver, manganese, antimony, arsenic, Cobalt, etc.

Generally speaking, a countrys economic life is influenced to a great extent by her natural resources and mineral resources. Among natural resources, minerals form a special importance as they are "wasting assets." They are also called non-renewable or exhaustable resources, once they are taken out of the ground and utilized, they are lost for ever. They should, therefore, be treated on a different footing from replenishable natural resources. Minerals figure in the export trade of developing countries and contribute to the earning of foreign exchange. They are exported, however, largely in the raw state.

As mineral resources from the basis of modern industry in peace and in war, it is necessary to have a rational policy as regards their working and utilization. The mineral required for the industry include iron, copper, manganese, chromium, cobalt, nikel, tungsten, etc. while coal, sulphur, pyrites, gypsum, oil, salt, limestone, rock phosphate etc. are used for fertilizer industry. The list of the minerals is a long one, but that of the non-metals is longer. Before the beginning of written history man knew the value of certain metals and sought the materials from which they might be obtained. A few metals that are used in large quantities, especially iron, may be thought of as fundamental resources.

The mineral resources of the world as at present known, may be exhaustible from resources view point, comprises an adequate range of useful products that are necessary for the industrial development of any country. An appraisal of the reserves shows that while in respect of mineral resources essential for basic industries—coal and iron–the resources are ample but many countries are deficient in mineral resources. These resources are generally known as the Geography of the Exploitation of the earth by Brunhes.

Geography of the Exploitation of the Earth

Under the general term 'Geography of the Exploitation of the Earth' should be grouped all kinds of destruction of the earth whose object is to take raw materials from the earth. All these manifestations of destructive economy are dependent originally on scientific and technical inventions.

The exploitation of the earth is also know as destructive occupa-

tion of the soil or economic plunder or Robber economy or destructive economy. A German phrase 'Raubwirtschaft' is generally used. In the words of Brunhes, 'Here and there on the earth, often near to houses, the soil has been pierced, and gaping holes mark the spots where men have removed the stone for their own use, without making any restitution. Sand-pits tufaquarries, sulphur-mines, quarries of marble or granite, rock-salt deposits—all these things, large and small, can be grouped under the term 'quarry.'...... Such mineral substances as silver, diamonds, coal, Salt or gypsum and the 'hole' in the earth is the actual sign of the destructive economy." The exploitation of mines is always a form of destructive occupation, in the sense that it is impossible to replace the materials taken from the earth.

Man's Relation to the Exploitation of Mineral Resources

Minerals provide the means in tools and machinery for increasing the productivity of all persons whether engaged in producing goods, transporting materials or performing service. Today more than a hundred minerals go into manufacturing processes. Not all of them are of the same magnitude of importance. Some are basic to essential industries, some are vital for defence, others contribute to desirable but non-essential industries. Iron ore and coal are basic and both are used in large amount.

The standard of living of people is measured by their productiveness. If a society has to be highly productive, it must be well equipped with power-driven machinery, which means it must have abundant supplies of iron. In the west, manpower takes the place of the machine and the standard of living is set by the physical strength of the human muscles. At one end is the highly industrialized economy of the United States aiming at two cars in every garage (already it has one car to every three inhabitans), at the other an agricultural economy composed of hard manual labour and cramping poverty.

Minerals form one of the life-lines of any major basic industry. It is essential that regular supply of mineral raw materials is ensured for obtaining the optimum utilization of the installed capacity of any particular industry.

Mineral are one of the basic commodities for building up a country's industry and economy.

Minerals play an important role in defence. Modern warfare is a war of steel and war machines would be completely paralysed without special alloy tool steels and aluminium alloys. This both in war and peace minerals have a vitally important part to play. High priority is therefore being given to the search for and exploitation of the mineral wealth of the country.

History tells of the drawing power of minerals from very early times. Different metals were used in different stages in succession. In Europe, bronze, copper and iron metals were also used in successive stages, as is clear from researches.

1. Op. cit. p. 38,

It is an established fact that iron came last and held an independent position in the successive metal periods as we get sufficient clue from oral transmission of knowledge from generation to generation. Bronze also has an independent position, but it is certain that bronze of various kinds came between copper and iron. On the contrary, copper which is found here or there or in many places of Neolithic and Bronze times does not hold any clear cut position in the successive metal stages.

Minerals in Early Civilizations

During the Second millennium the knowledge of metals and ores spread far and wide from eastern coast of the Mediterranean sea along the usual tarde routes. From the westeen Mediterranean the mineral ores of Spain were exploited in pre-Mycenean times and it played a most important part in its contribution towards the industrial development of Southern-Europe. Gradually, the trading of minerals was also brought to the British Isles. The traffic in minerals also reached British Isles along the Atlantic coast and there most valuable and rich ores were discovered and turnwise supplied to the markets of the north-west and south of the same.

Next remarkable discovery of metal was made in Ireland. But, there is great controversy in respect of its route through which it was discovered. According to G. Coffey[1] the route was either through the River Elbe or by way of Scandinavia. Ireland's richness in gold during the Bronze Age entitled "a kind of Eldorado of the western world".

Copper was first used for polishing stone implements and then was associated with bronze and iron. In Europe, North Italy, Hungary and Ireland may lay claim to a copper age, but there is very little evidence of such a stage in Britain. J. Hampel has fully mastered this subject and holds on solid ground that in some regions, for especially Hungary, copper played a most important part for many centuries, and, there is hardly any doubt that copper is the characteristic metal of a distinct culture.

In respect of copper age, Hampel reveals, after through survey and inspection of facts and figures, that there was definitely a copper age prevailing in Europe, Egypt, North Asia and some other lands, where the ore was in existence. After a thorough survey of the geological features of the land, he also reveals that such a culture was the natural effect of the features of the earth as copper and ore, both were found side by said in the Ural Mountains in Eurasia and the Altai Mountains in Asia and North of Italy and some places of Spain, Britain, Cyprus and Sinai. We know very well that there was independent copper age in the Katanga districts and other parts of central Africa. Copper is not alloy, but a soft metal available in a pure state in various parts of the world. Still,

1. G. Coffey, The Bronze Age in Ireland, pp. 547–48, 1913.

we simply wonder to note that in a short period the bronze alloys took the place of copper.

However, the passage from copper to bronze was slow and progressive, the proper portion of time which was preceded probably in some places by an alloy of antimony, having been arrived at—apparently by repeated experiments, often carried with full vigour and skill by those prehistoric metallurgists.

KINDS OF MINERALS

For geographical study they are grouped as followes :—

1. **Non-metallic Minerals**——Futher subdivided into—

(*a*) **Building Materials** such as Building stone, sand and gravel, clay, cement etc.

(*b*) **Mineral chemicals** for example salt, sulphur, asbestos, yypsum etc.

(*c*) **Gens** such as agate, beryl, garnet, zircon etc.

2. **Metallic Minerals**—Subdivided into—

(*d*) **The Ferro-alloy metals** such as iron, chromium, cobalt, nickel, tungsten, manganese etc.

(*e*) **Non-ferro or Semi-Precious metals** for example, copper, zinc, lead, antimony, gluminum, magnesium etc.

(*f*) **The Precious Metals** such as gold, silver, platinum etc.

3. **The Mineral Fuels** or Power Resources such as coal, petroleum etc.

BUILDING MATERIALS

In many countries the close relations between rocks and man often appear very clearly. The ordinary man, however, lives in an ordinary house which used to be built of local materials, whatever was nearest and most abundant.

In the absence of statistics, it is difficult to express shortly the trade in a material so widespread as common building stone. There are, however, a few features which are specially developed in, if not peculiar to, India. In the southern part of the Peninsula, various igneous rocks—the Charnockite series near Madras, and the gneissose granites of North Arcot and Karnataka—are largely used; in the centre states and limestones from the Cuddapah series, and basalt from the Deccan trap-flows are quarried. In Madhya Pradesh, and U. P., the great Vindhyan system provides incomparable sandstones and limestones, while in Bengal and in Orissa the Gondwana sandstones are used on and near the coal-fields. In the Narmada valley the so called coralline limestone of the Bagh series forms an excellent building stone with a certain claim to inclusion in the ornamental class. Among the younger rocks the nummulitic limestones in the north-west and in Assam are largely quarried. while the for aminiferal Porbandar stone in Gujarat and Kathiawar is extensively used in Bombay and Ahmedabad.

The abundant development of concretionary carbonate of lime

in the great alluvial plains and the extensive development of laterite on the Peninsula and in Burma are dependent, in their more pronounced forms, on conditions peculiar to Tropical climates, and these two substances, the so called **Kankar** and laterite, are about the most valuable assets in building material possessed by the country.

A quartzite of good quantity from Susunia Hill, Bankura, has been largely employed in Calcutta for paving and curb stones. In Burma, sandstone is quarried in many districts, amongst which may be mentioned the Northern Shan States, Meiktila, Thaton, Mnidu, Akyab, Kyaukse, etc.

The subject of building materials naturally includes limestone used as a building stone, and the two derived products—lime and cement; these are obtained, obviously, from the most conveniently situated deposits of limestones, such as those of the upper Vindhyan series worked near Sutna in the former Rewa state now in Madhya Pradesh, those of the lower Vindhyan series worked at Katni and others, those worked in the Cuddapah series at Bisra and Rourkela, or the various bands of crystalline limestones in Tamil Nadu, Rajasthan and Madhya Pradesh, etc.

Vast quantities of limestone suitable for building-stone or for lime-burning, are available over large areas of Baluchistan, Nepal and Bedford limestone from the Bedford-Bloomington district in Indiana etc.

CLAYS

The important part played by clay in the industrial development of a country is not generally recognised, but can easily be illustrated by reference to the mineral statistics of such an industrialy advanced country as the United States. Based upon clay as a raw material are the brick, tile, pottery, porcelain, and terra cotta industries. Examples of districts noted for fine pottery wares are New Jersey and the Ohio valley in U.S., Saxony, Bavaria and Central France.

In India the common clays, derived largely from the silt of the large rivers and used all over the country for the manufacture of bricks, tiles and the cheaper forms of pottery; finer varieties used for glazed pottery, which in places has obtained a reputation for artistic merit; fine clays raised in considerable quantities on some of the Gondwana coal-fields; the Fuller's Earth, known as **multani-matti** is also worked in Bikaner, Jaisalmer and Madhya Pradesh.

MINERAL CHEMICALS

Salt—The salt produced in the world is obtained from three principal sources, viz.,

1. From sea-water,

2. From subsoil water and lakes in areas of internal drainage, and 3. from rock-salt beds.

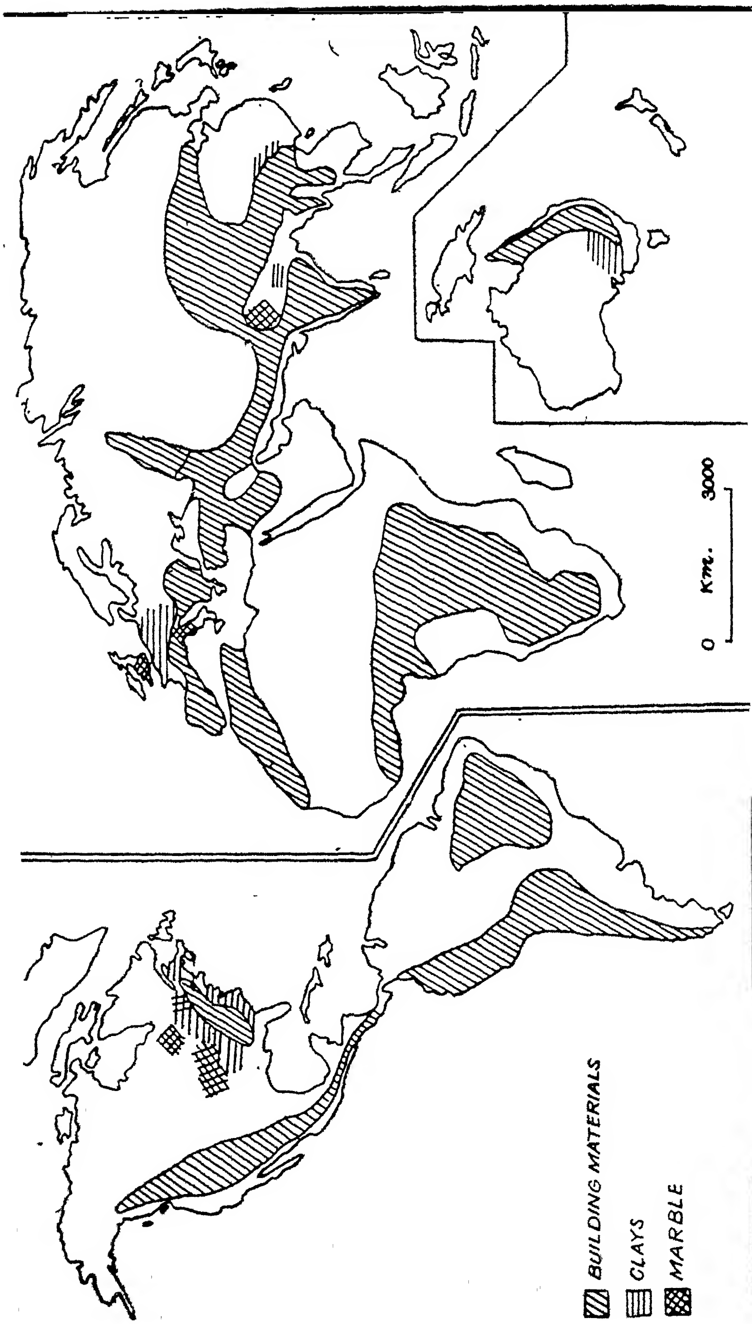


Fig. 9·1. Building Materials

In North America there are four chief areas of salt mining—

1. The North eastern states such as New York, Ohio, Michigan and Ontario,
2. The Mid-continental belt or Kansas state,
3. The Gulf coast States,

and 4. the western states such as California etc.

In India, by far the largest amount-about 60 percent—is derived from the first source or from sea-water chiefly in Maharashtra and Tamil Nadu while the rock-salt beds of the Himalaya west and of Mandi in Himachal Pradesh provide about one-tenth of the Indian output.

Maharashtra, as before, is the chief producer, most of the salt being obtained from sea-water, supplemented by the use of sub-soil brine on the border of the Rann of Kutch in an area where, possibly, the brines are directly derived from sea-water. In Tamil Nadu and Andhra coast, small quantities of salt are collected in the Masulipatanam area, but the rest is manufactured from sea-water.

In many areas of internal drainage there are small temporary salt-lakes which are utilised, as at Sambhar and Didwana; while in other places sub-soil brine is raised, as at Pachbadra. Most of the salt in this region appears to be brought in as fine dust by the strong winds which blow from the south west and south-south-west during the hot weather. These winds blow across the salt-incrusted Rann of Kutch, and carry away the finely powdered salt in large quantities into the heart of Rajasthan, where is becomes fixed when the following monsoon brings rain enough to wash the salt into the small lakes in areas of internal drainage.

SULPHUR

There are two common modes of occurrence of Sulphur, (*a*) in the native state, known as brimstone and (*b*) as pyrite or a Sulphide of iron. Formerly, all of the world's supply of brimstone was dug from volcanoes. Small quantities of sulphur are obtainable on the dying volcano of Barren Island in the Bay of Bengal, in the state of Kelat in Baluchistan, and on the Koh-i-Sultan, and neighbouring volcanoes in Seistan and Eastern Persia.

The most important commercial deposits in the world are to be found in Louisiana and Texas, Sicily, Japan etc. India is poor in Sulphur which is the basic component of the heavy chemical industry. At present all sulphur needed by us is being imported either from Sicily, Japan or from U.S.A. To replace totally or even partially this imported Sulphur, India can only fall back upon the scanty deposits of pyrites near Simla. Still more inaccessible deposits in Assam and comparatively good deposits of gypsum in Madhya Pradesh are also available.

The other source, not of any considerable magnitude, is in the recovery of Sulphur oxide produced in the roasting of copper ores near Ghatsila which produces about 7,000 tons per year. Another

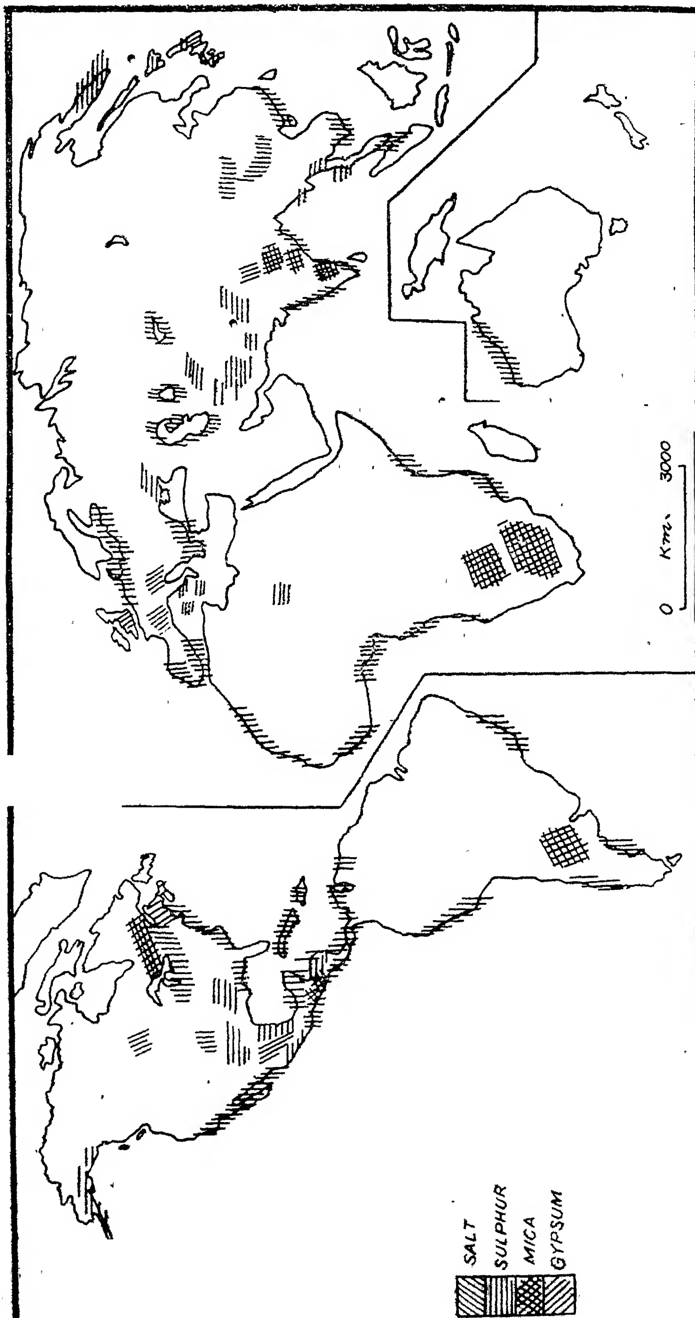


Fig. 9 2. Mineral Chemicals

source that is tackled even in highly industrialised countries abroad is coal. But our coal is poor in Sulphur, except the deposit of a Tertiary nature in Assam, where the organic sulphur content is very high.

MICA

Mica is used in a large number of industries, in medicinal preparations and for decorative and ornamental purposes. It is now regarded as one of the chief strategic minerals. It enjoys certain special qualities like transparency, breakability into thin films, flexibility, elasticity and resistance to heat. Hence, it is used in making lamp chimneys, fronts of stoves, furnaces, protective spectacles, fire proof points, patent roofing materials, in wireless telegraphy, radio communication, aeronautical engineering and motor transport. Ground mica is used as a lubricant.

However, the chief use of mica is for electrical purposes as an insulator. Formerly only larger sizes of mica were in use, but during the war smaller sizes also became marketable. This is largely due to the development of the micanite industry. Micanite of mica is really the built-up sheets of the smallest and thinnest films which are connected together with shellac dissolved in spirit. The micanite sheets can be built to any size and thickness. They require to be steamed, pressed and rolled, and then can be moulded to any desired shape. India has practically a monopoly of mica and shellac used in making micanite.

Mica is a group name for several minerals which, though differing in chemical composition and physical properties, are characterised by their ability to split readily into very thin plates or flakes which are more or less tough, elastic and transparent according to variety. Only the three following varieties are known commercially as mica :—

(*a*) Muscovite or white mica,
(*b*) Phlogopite or amber mica,
(*c*) Biotite or black mica.

The Canadian product consists of phlogopite, while that from India and United States of America is mainly muscovite, and comes entirely from the provinces of Ontario and Quebec. Mica-bearing pegmatites also occur in Namaqualand, Pietersburg district of the Transvaal and Southern Rhodesia. Mica is known to occur in the Cameroons and Nyasaland. The Argentina and Guatemala also report exports of small amounts, but in both the latter countries the mica deposits are said to be of great potential value.

The chief mica-mining areas in India are those of Hazaribagh in Bihar and Nellore in Andhra. Mica has also been obtained from workings in the Eranial taluka of Kerala, the Hassan district of Karnataka and Ajmer and Udaipur districts in Rajasthan.

The Mica Belt of Bihar obliquely traverses the districts of Gaya. Hazaribagh and Monghyr, along a strip about 19 kilometres broad and over 96 kilometres long. A large number of the more

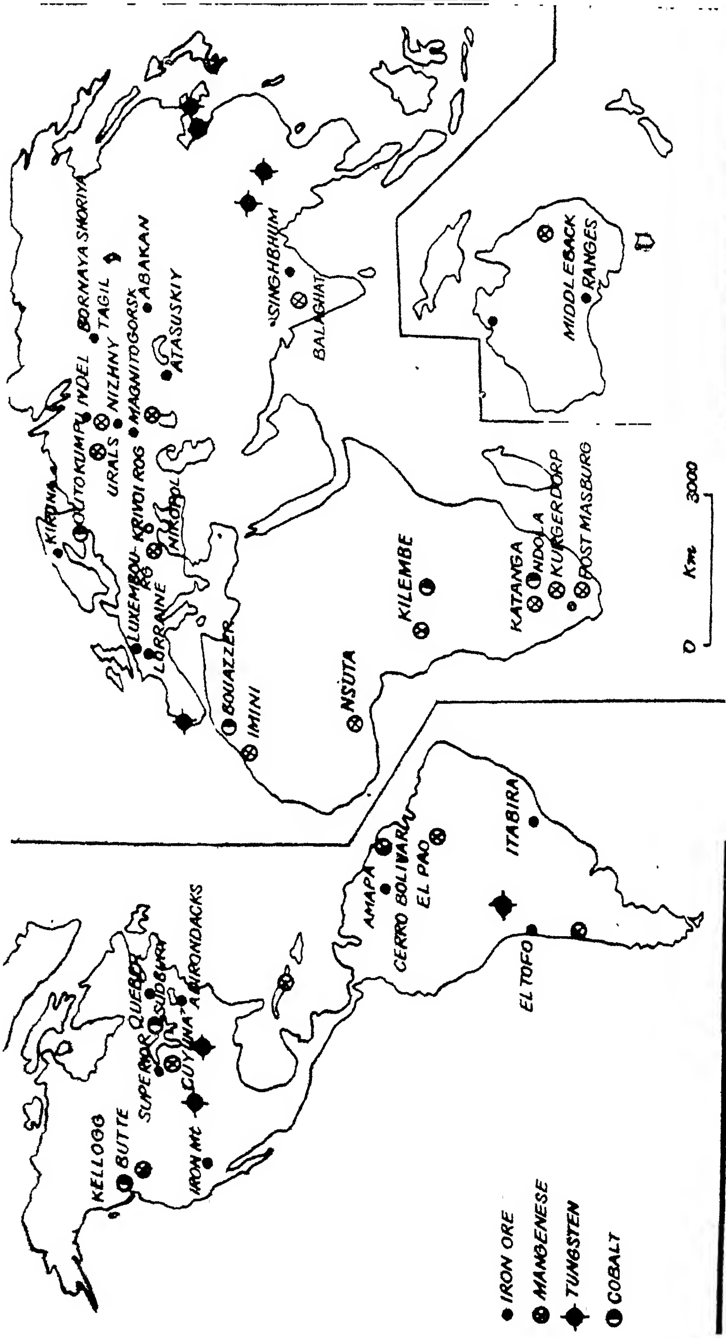


Fig 9 3. Metallic Minerals Producing areas.

important workings are situated either in or near Kodarma forests especially at Koderma, Domchanch, Giridih, Chakal, Dhaw etc. By far the larger proportion of the Indian output of mica is obtained from "Bihar Mica Belt", although the mica is often commercially spoken of as 'Bengal Mica'. All this mica is sent to Calcutta whence it is exported.

Workable deposits of mica have been located in Orissa in the districts of Ganjam, Koraput Cuttack and Sambalpur. Mica deposits are found in Andhra at several places, the most important being those of the Nellore district. Mica deposits also occur in Vishakhapatnam, west Godawari, Salem, Nilgiri, Madurai and Coimbatore districts and also in the state of Kerala.

GYPSUM

Gypsum ranks next to coal and iron as a mineral of great importance in the industrial economy of the world Before the Second World War, it was used mostly as a raw material in the production of cement and plaster of Paris. Plaster of Paris, wall plaster, stucco, and plasterboard are the principal products which are derived from Gypsum. It has now gained in importance as a raw material in the manufacture of Ammonium Sulphate, an important fertilizer. It can be used as a source of sulphuric acid.

Gypsum deposits are known to exist in several parts of India. The more well-known gypsum-bearing regions are in Rajasthan and in south India, but smaller deposits occur also in Tehri Garhwal and parts of western India. Gypsum is also found in Spiti and Kanaur in Himachal Pradesh. Between the Lipak and Yuland rivers in Kanaur the gypsum occurs in immense masses and thick beds replacing carboniferous limestone.

GEMS

The term gem includes a great variety of non-metallic minerals. Gem minerals are used for such diverse purposes as jewelry, industrial arts, abrasives, drill poins and ceramics. Amongst prehistoric relics found in various parts of the world, both nephrite and jadcite implements and ornaments are widely distributed, and an admiration for the beauty of the stone, descended from a belief in its magical properties, maintains the value of the mineral in the eyes of the Chinese, who are the chief buyers.

Jadestone or nephrite has been known in China from a period of high antiquity. It was found in Khotan and other parts of Central Asia, the most valued variety being the costly milk-white kind held in high esteem as symbolical of purity in private and official life. Jadeite has been found in the Mawlu township of the Katha district, upper Burma, and is also reported from Tibet.

RUBY

The rubies are derived from crystalline limestones which stretch westwards from Mogok as far as the Irrawadi. Rubies are known to occur at Naniazeik in the Myitkyina district of Burma.

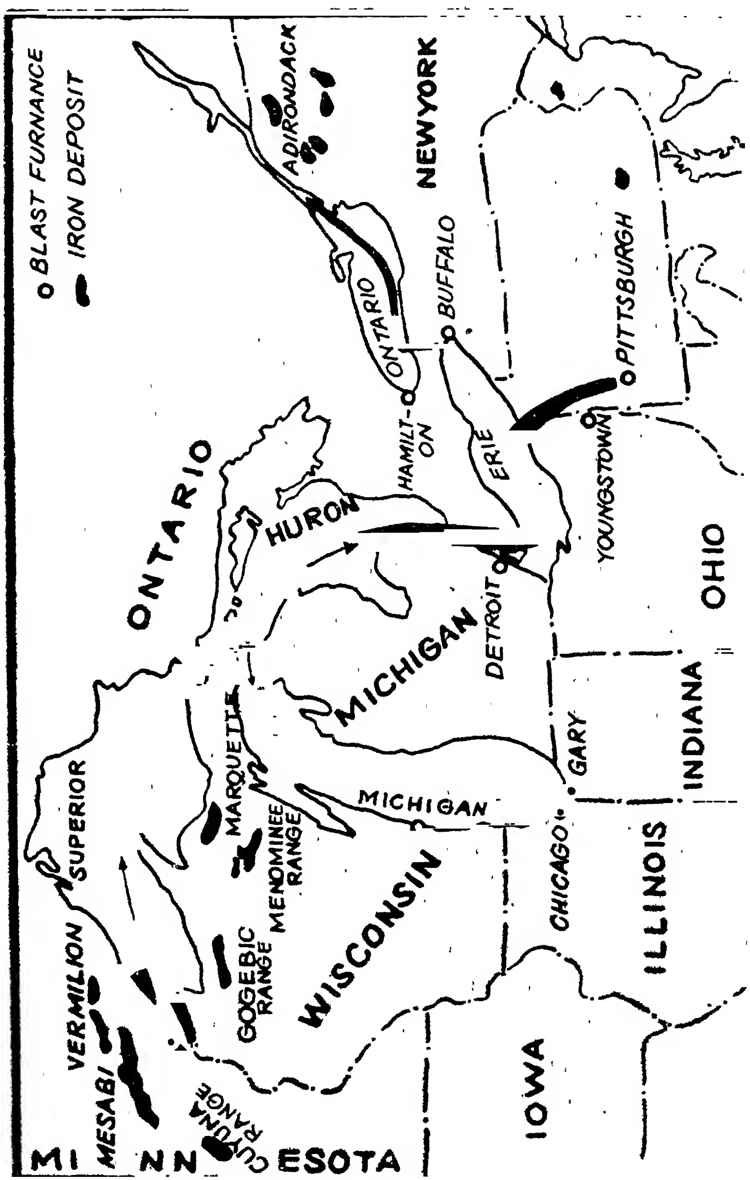


Fig 9 4. Iron Producing areas of Superior Lakes

DIAMONDS

The upper Vindhyan System of India is remarkable for including rocks in which diamonds are found. In the neighbourhood of Panna the principal diamond-bearing stratum is a thin layer of conglomerate, locally known as '*mudda*' lying between the upper Kaimur sandstone and the Panna shales. Another diamondiferous conglomerate occurs above the Rewa sandstones and under the Bhander series.

Diamonds are produced almost in Africa especially in Congo, Ghana, Angola, Rhodesia ; South America and Yakutia and Mir districts of U.S.S.R.

AGATE

The agates come from various states and districts on or near the edge of the trap, the chief sources of supply being the Kishtna, Godawari, Bhima, Narmada and other rivers draining trap-covered areas. A certain amount of agate-cutting is also carried on at Jabalpur in Madhya Pradesh, at Banda in U P., and at a few other places within range of the Deccan Trap. Much of the agate retailed in Europe is sent from Bombay and Cambay, and large quantities are also exported to U.S A.

Of the precious and semi precious stones of the world, the most important, amber, diamond, ruby and Jadeite, have been already referred to. Of the others, the only ones that are of immediate concern are beryl, garnet, tourmaline and turquoise.

METALLIC MINERALS

Metallic ores occupy the basic position in the economic life of the modern world. There are numerous uses to which the ores are put, but their greatest use is in the manufacture of machinery without which the wheels of the industrial world cannot go on.

IRON

Worlds resources of Iron ore are of large dimensions. Ores of good quality occur in U.S.A., Canada, U.S.S.R. Germany, France, England, China and India. Fig. 9·3 shows the important Iron ore producing areas of the world. Iron ore in commercial deposits is concentrated in a few places in the United States. The principal mining areas in the Lake Superior Region are Vermillion range, Mesabi Range, Cuyuna Range, Gogebic Range, Menominee Range, Marquette Range and Iron Mountain etc. see Fig 9·4. About 75 percent of the ore used in the United States comes from the Lake Superior region. The United States is focussing increasing attention on such newly discovered deposits as those of the Quebec—Labrador, Iron Belt of Canada and Cerro Bolivar and El Pao regions of Venezuela by the help of CVRD.

France, with the largest Iron-ore deposits in continental Europe, is the dominant producer in western Europe. Over 90% Iron ore mined annually in France comes from Lorraine. In north west France there are deposits of Iron ore on the northern and

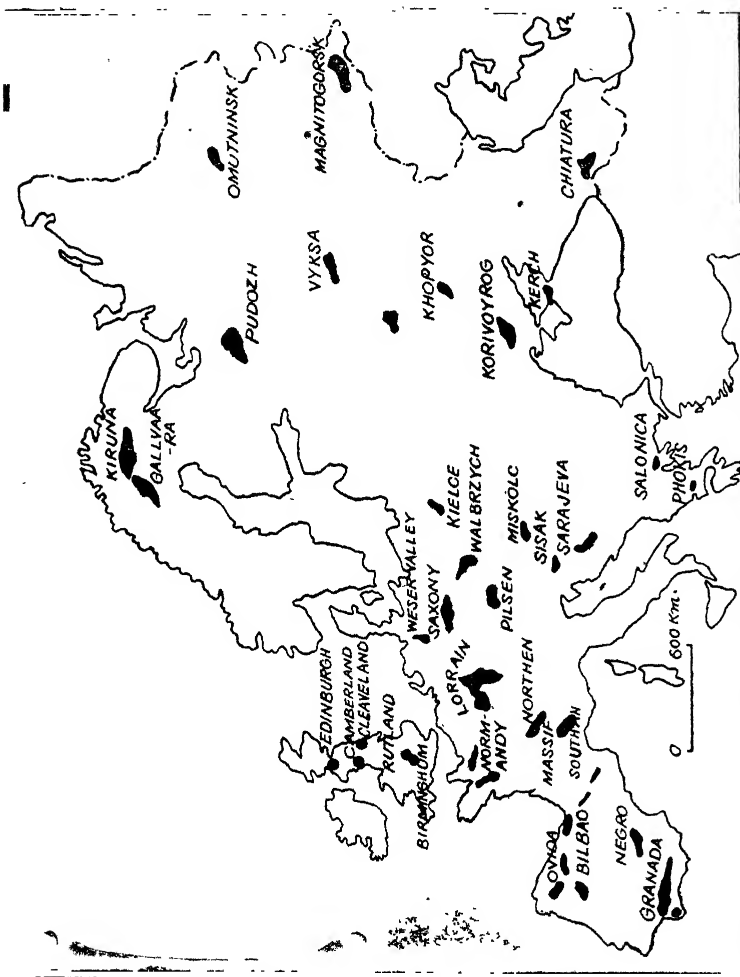


Fig. 9 5. Iron Producing areas of Europe.

southern edges of the Armorican Massif. The mine at Kiruna in Sweden is the word's largest underground Iron-ore operation. The exported ore goes to Belgium, Germany, U.K. and United States. Fig. 9·5 shows the Iron resources of Europe.

After U.S.A. next in importance in Iron and Steel production is the Soviet Union. Principal Iron fields are at Krivoi Rog in the Ukraine, on the Kerch Peninsula of the Crimea, Gornaya Shoriya, in the Ural mountains and Kazakhstan, as shown in Fig 9·6.

Principal Iron ore reserves and mining centres are in China near Chahar, Hainan Island, Honan, Hupeh, Kansu in the Kilien Mountains, Kweichow, Paiyunopo in Inner Mongolia, Anshan and Penki in Manchuria

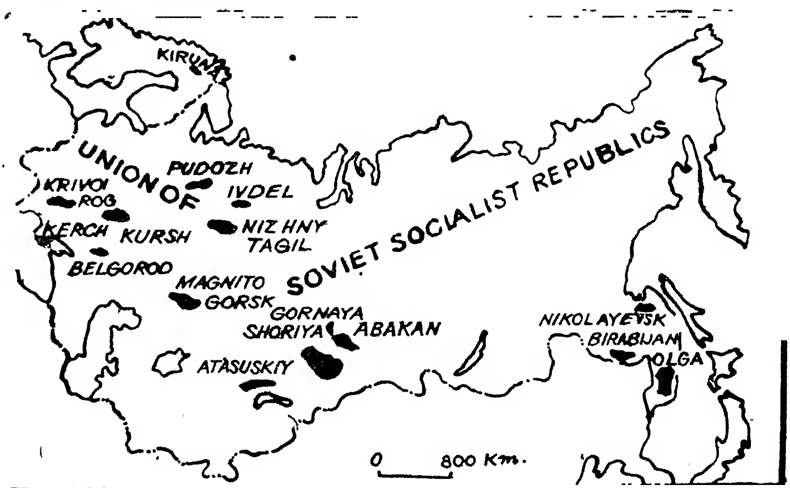


Fig. 9·6. Iron Resources of the U. S. S. R.

Currently Algeria, Liberia, and South Africa are the most important produces ; but Morocco, Egypt, Gabon, Guinea, the Rhodesia, Sierra Leone and Mauritania also have commercial deposits, some of which are being worked.

Bihar, Orissa and Karnataka are the only parts of India in which large quantities of iron ore are mined. Elsewhere specially in Andhra and Madhya Pradesh small quantites are mined for use in indigenous Iron works. The most important iron ore area in India is situated about 240 to 320 kilometres to the west of Calcutta in Bihar and Orissa, and contains large and rich deposits of Iron-ore which is shown in Fig. 9·7. The iron ore in the districts of Singhbhum, Keonjhar, Bonai and Mayurbhanj, usually occurs at or near the top of hills. Near Jamda in the South of the Singhbhum district and in parts of Keonjhar, however, it is often found at lower slopes and in some cases actually in the plains themselves.

In Singhbhum district the iron-ore is mined in Kolhan where the important places are Pansira Buru, Gua, Buda Buru and Noamundi all in Bihar and Orissa states. Iron-ore occurs usually at or near the tops of hills, the most important being the range running from about 4 kilometres South-west of Gua to the Kolhan-Keonjhar boundary east of the Navogaon, *i.e.*, a distance of about 16 kilometres. Parallel to this range is another similar line of hills running from the Duargui Stream, four kilometres east of Bada, to the Karo river South-east of Ghatkuri, a distance of about 12 kilometres.

The occurrence of valuable iron-ore deposits in Mayurbhanj was first noticed by P. N. Bose[1] who mentioned the following occurrences—

1. Bamanghati Sub-division—

(*a*) Gurumaishini Hill, over an area of 16 km.^{2},

(*b*) Near Bandgaon in Saranda-pir,

(*c*) Sulaipat Badampahar range from Kondadera to Jaidhanposi, a distance of some 19 kilometres.

2. Panchpir Sub-division—

At several places from Kamdabedi and Kantikna to Thakurmunda, a distance of 40 kilometres.

3. Mayurbhanj Proper—

Similipahar Range, and the Sub-montane tract to the east of Gurguria, Kendua and Baldia.

In Karnataka, the haematite ores of the Bababudan hills are the most abundant and are of good quality, but they vary considerably in their metal content and the amount of phosphorus they contain.

The main sources of the ore supply for the Bhadravati Iron Works of Karnataka is the Kemmangundi ore field, about 41 kilometres south of Bhadravati.

Rich ores occur in Madhya Pradesh and Tamil Nadu, they are worked very little, being far away from coal. In the Durg district of M. P. the ores, on account of their resistance to weathering agents, stand up as conspicuous hillocks in the general plain.

In the Chandrapur district of Maharashtra the iron ore froms a hill three-eights of a km. in length, 182 metres in breadth and 36 metres high. This hill is called the Lohara hill.

The ore found in Bellary (Karnataka) and Kurnool, Cuddapah and Chittor districts in Andhra Pradesh is different in kind from the ore found in Orissa and Madhya Pradesh. The ore is magnetite. The principal occurrences are those of (1) Godamalai, (2) Thalamalai—Kolimalai, (3) Singapati, (4) Thirtamalai and (5) Kaniamalai.

Production of Iron Resources

The average annual production of iron ore resource during the

1. Rec. G S. I. Vol. XXXI, 1904.

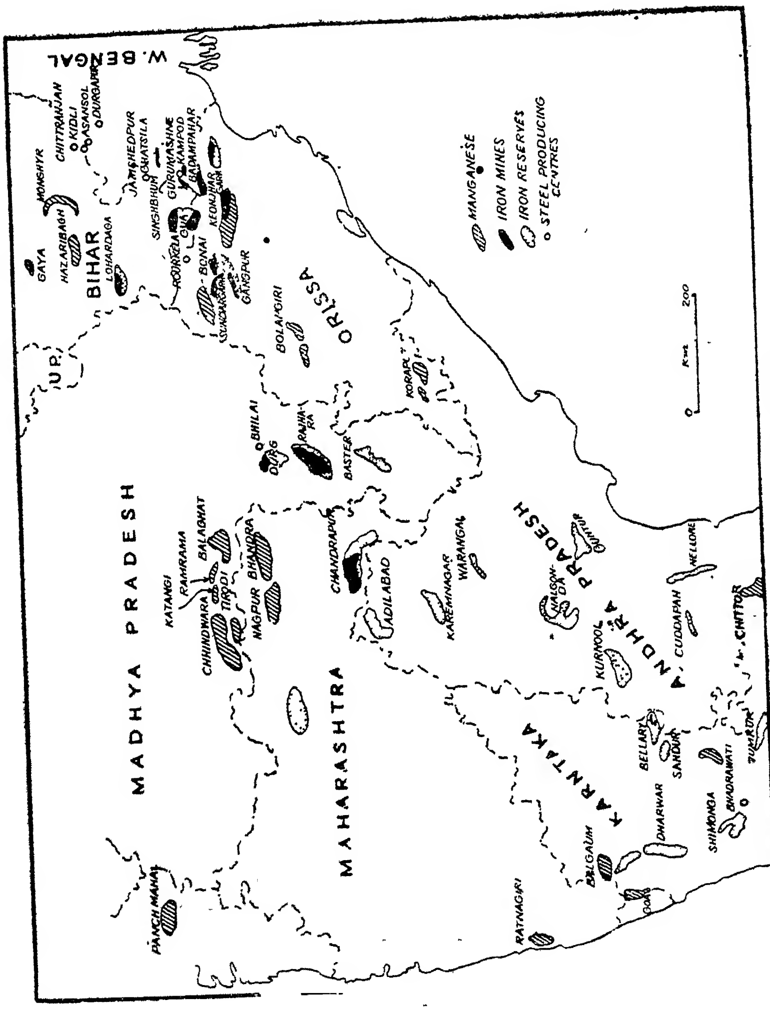


Fig. 9·7. Ore Regions of India

past few years has been varying between one to three thousand million tons, the chief producing regions being in the western hemisphere particularly U.S.A. The United States of America's share in production has been varying between 771 to 850 million tons and practically all the rest has come from Australia, Venezula, Belgium, Republic of South Africa, U.K. and Canada. The Soviet Union is also leading producers in Iron resources of the world The following table 9·1 shows the production of iron resources of the world.

Table 9·1

Production of Iron Resources of the World.[1]

Country	Year	Production (000 tone)
Algeria	1972–73	314,700
Australia	1972–73	386,400
Austria	1971–72	4,171
Belgium	1972–73	118,950
Bulgaria	1971–72	13,780
Canada	1971–72	48,475
Czechoslovakia	1972–73	100
Federal Repblic of Germany	1972–73	17,200
Japan	1971–72	8,620
Republic of Korea	1972–73	492
Luxembourg	1971–72	4,507
Mexico	1970–71	2,818
Morocco	1970–71	3,650
Peru	1971–72	88,490
Poland	1972–73	70,780
Romania	1972–73	33,610
Republic of S. Africa	1971–72	104,960
Sweden	1972–73	33,929
Turkey	1972–73	954
U. K.	1972–73	89,060
U. S. A	1971–72	771,060
Venezuela	1972–73	194,000
Yugoslavia	1971–72	39,600

More than fifty countries are engaged in mining iron ore, we find that more than 80 percent of the world's iron resource is

1. International .Year book, 1974, F. A. O. Publications, UNO Publications etc.

mined each year in the United States, the Soviet Union, France, Sweden, Great Britain, Germany and Belgium-Luxembourg. In terms of metallic content, the probable iron ore resources reserves of Indian Republic and Brazil are the largest in the world (as shown in table 9 2) but India, however, mines less than 1½) percent of the world's iron ore while Brazil ranks even lower.[1]

Reserves of iron ore

Indian Republic has got good reserves of iron ore in the world. From the matallic content ranging up to 51 percent or more they occupy a very high position in the world. Apart from this high metal percentage, these ores are also notable for their lower sulphur content which never rises above 0·6 percent. Both in quantity and quality these ores are regarded as superior even to the great American occurrences of Minnesota, Wisconsin and Michigan. In the United States which is fortunate in having large and rich deposits, nearly all the ore that is mined has an iron content of more than 50%. The world's richest deposits, with an iron content exceeding 65%, are found in iron Knob district of southern Australia, the Krivoi Rog district of southern European Russia, at Itabira in Eastern Brazil, at Kiruna in northern Sweden, and at Eltofo near Coquimbo, Chile. Very little ore is mined today that contains less than 30% of iron. The maximum percentage of metallic iron found in **magnetite** is 72 8%, in **hematite** 70 percent, in **limonite** 59·9%, and in **siderite** 48 percent.

The iron ore reserves in the iron belt of Bihar and Orissa are estimated to be sufficient for a thousand years with a pig iron output of 15 lakh tons annually.

The table 9·2, as under giving the estimated potential ore reserves in different countries, will be found interesting. It shows how the iron resources of India are considerable.

Table 9·2

Estimated iron resources of the world[2]

Country	Billions of Metric tons		Metric tons		Percentage of Iron Content
	Total Probable Reserves	Total Potential Reserves	Probable Reserves per capita	Potential Reserves per capita	
India	5·6	10·3	16	30	51
Brazil	4·1	10·8	85	223	55
France	2·5	3·9	61	93	37
U.S.S.R.	2·0	4·3	11	23	—
United States	1·7	25·3	12	174	50

1. World Iron ore Resources and their utilization, U. N. Dept. Eco. Aff. 1950 or Focus April, 1951.

2. U. N., Dept. of Eco. Affairs, op. cit. pp. 66-67 and U. N. O World Iron ore Resources, 1952.

Sweden	1·4	1·6	205	233	64
union of S. Africa	1.3	5·1	107	428	47
Cuba	1·2	5·4	233	1047	36
Southern Rhodesia	1·1	50·7	577	24,591	55
Western Africa	1·0	1·0	63	63	74
Canada	·9	2·2	70	168	50
China	8	1·2	2	3	45
Great Britain	·7	·9	13	18	27
Philippines	·5	·5	24	24	—
Spain	·4	·6	13	23	36
Algeria	·4	·5	—	—	55
Venezuela	·9	9·4	—	—	51
All others	1·5	4·8		—	—
World Total	27·6	138 2	11	55	—

In case of India, the ores is most cases contain a high percentage of metallic iron (over 60%) and are generally low in phosphorus and sulphur. Reserves of good quality iron ore (containing over 60% iron content are estimated to be over 10,000 million tons[1], the balk of which is concentrated in Bihar and Orissa.

International Trade of Iron Ore

Iron ore in commercial deposits is concentrated in a few places of the world. Development of large mines with matching transport and port systems over the last few years in Australia, Africa, Brazil and Peru has resulted in over supply of iron ore and a consequential decline in prices. These countries have emerged with highly efficient integrated mine-to-port complexes. The complexes in Australia, Brazil and Peru can supply 20 to 30 million tonnes a year of ore of the type and form desired by buyers.

Japan is one of the principal countries importing iron ore on a large scale There has been a phenomenal increase in the production of steel from around 11 million tonnes in 1955 to 62 million tonnes in 1967. By 1977, Japanese ore imports are expected to increase to 120 million tonnes.

Japan is the single largest importer of Indian iron ore. Of about 16 million tonnes are exported by India in 1968-69, major shares of this export went to Japan. It is evident that the rapid expansion of the steel industry in that country makes it imperative for it to make long term arrangements for iron ore imports. Therefore, it can reasonably be hoped that India can secure an appropriate share of the increased requirements of Japan provided an earnest attempt is made to utilize the modern developments and technique adopted in other countries exporting iron ore. Our

1. Fox, C., G S,I. 1932.

competitors in the Japanese market for iron ore are Philippines, Canada, U.S.A., Malaya and Manchuria. Our iron ore is exported specially to Japan, U.S A. and Great Britain.

With the increasing demand of iron ore, Australia and Venezuela have come up with very large iron ore complexes. Australia, Brazil, Peru and Liberia are making all out efforts to produce iron ore at the cheapest possible cost so as to be abletocompete in the international ore trade. Ore prices have shown a downward trend for the last ore decade and competition has become very stiff.

These countries have been able to run their complexes economically and efficienty as they have integrated complexes under single agency control, which is called CVRD. In Australia and Canada, where many of the projects are owned by many companies belonging to different countries, operating control is left to only CVRD.

At present CVRD is collaborating with the United States Steel of America for prospecting, development and exploiting new iron ore resources in the Amazon Valley. If these surveys are successful Brazil in the very near future will have another big iron ore complex, which will not only be able to complete with other countries for export but will also have an assured off take of major part of the product due to the participation with the United States Steel. CVRD is a agency, which ogerating control of the entire complex till the ore reaches the consumer is in the hands of a single agency. This single agency control has inducted efficiency into the system, besides several other advantages.

(1) Increasing the scale of operations at the mines with facilities to produce processed ore either at the mine or at the ports or at both. (2) Introduction of unit trains with capacities of 10,000 to 15,000 tonnes per train. (3) Development of pors, which can accommodate ships of over 100,000–150,000 tonnes with high loading rates so as to load a ship within less than 24 hours.

For achieving the maximum possible economies and efficiency in all stages of handling the ore operations and for enabling the developing the nations ore to complete in the international market, a new approach-integrated management of the ore export complex has to be adopted. At present in India, for example, there is a multiplicity of agencies, with mines under the control of one authority road transport under private transport contractors, rail transport under the Railway Ministry and port operations under port authorities. All the technical teams, which have studied iron ore export trade from developing nations, just like India, have recommended unified control of these operations by a single agency.

MANGANESE

Manganese, having so many remarkable qualities, has found wide application. Some of the applications are in special tract layouts, points, crossing etc. On railways wearing parts of rock

crushers bucket lips of excavators and dredgers and many others items of mining equipment, wire line sheaves for oil well machinery, and many items in mechanical engineering.

Manganese in the form of alloys with iron and silicon is used in the manufacture of steel. In recent years a gradual reduction has taken place in the quantity of manganese consumed per ton of steel ingots.

Among non-ferrous alloys only the alloys of aluminium and copper have commercial importance. Copper manganese alloy is used for turbine blades with only 4% manganese. 'Manganin', of industrial importance when used as low-temperature co-efficient of electrical resistance, contains 8% to 12% manganese and 4% nickel. Manganese bronze contains 0·05% to 3·5% manganese besides the usual copper, zinc, iron, tin, silicon, nickel or aluminium. The commercial use of this alloy is for rolling into sheets, for drawing into wires, for sand casting, for propellers of ships, and for mining machinery. The hardness of aluminium increases when a little manganese is added to it. It also helps to resist more effectively corrosion by sea-water. For sparking plugs, an alloy of 96% nickel and 4% manganese is used. Besides these, there are various other alloys which contain manganese in small quantities.

Chemical (pyrolusite) is used principally for the manufacture of dry cells. It acts as a depolarizer. Ore used should contain much oxygen as in pyrotusite and very little iron, and be free from copper, nickel, cobalt, etc., which are electronegative to zinc.

Manganese oxide and other manganese compounds are added to act as driers to vegetable oils. The consumption of manganese compound in this trade is appreciable. For use as pigments the following manganese carbonate, known as manganese white, manganese oxide known as manganese green, manganese metaphosphate known as manganese violet, and pyrolusite known as manganese black. Manganese phosphate is used as a protective coating for steel. Manganese dioxide is used for news-print purposes.

Pyrolusite is used for the manufacture of iodine and chlorine, in the latter however it is now being replaced by the electrolytic process. As an oxidizing agent, manganese dioxide is used for certain chemicals, including hydroquinone.

Manganese sulphate in used as a manure in combination with commercial fertilizers in alkaline soils. About 50 to 100 lbs. per ·4 hectares are required for the purpose.

Manganese chloride is used for dyeing cotton, manganese sulphate is used for calico printing, and ore of chemical grade is used in a small quantity for match industry. A mixture of manganese borate, linseed oil and resin is used for the leather industry.

India has fairly large deposits of manganese ore and is one of the chief producers; others are U.S.S.R., Brazil, South Africa and Gold Coast. Except U.S.S.R., none of the other great industrial

countries possess manganese deposits of importance and deposits of India therefore assume especial importance.

Production of Manganese ore

Production of manganese ore in U.S.A. is insignificant compared to the total quantity consumed by them. In year 1972–73, the United States of America imported about one million tons of Indian manganese ore *i.e.*, 40% of their total imports of about 2·8 million tons and the balance mainly from South Africa, the Gold Coast, Congo Republic and South American countries. The Soviet Union is estimated to have produced five million tons which was about 50% of the total world output of 10·8 million tons. Indian output is the next highest with 1·6 million tons which was approximately 15% of the total world output. South Africa came third with 0·1000 million tons, *i.e.* about 8 percent of the total world output.

The following table 9·3 shows the production of manganese ore in India in comparison with some other principal countries of the world.

Table 9·3

Manganese Production[1]

Country	Production in tons
U.S.S.R.	7,385,000
Brazil	1,320,000
Congo Republic	348,547
Ghana	434,410
Ivory Coast	153,291
Republic of S. Africa	3,418,000
Philippines	5,133,000
China	110,000
India	118,000
Chile	51,235
U.S.A.	10,622
Morocco	160,000
Mexico	9,608
Peru	1,089
Yugoslavia	8,964
Australia	40,500
Spain	10,000
Japan	268,000
Malaya	8,000

1. The International Year Book, 1973 and 1974, U N. Statistical year books 1970 to 1974.

Thailand	6,786
Turkey	1,400
Iran	1,100
Angola	50
Burma	220

Reserves of Manganese

Manganese is an important industrial mineral used in the smelting process of the Iron and Steel industry. The Indian reserves of manganese are by far the largest in the world.

The total is estimated at 1,000 million tons of ferro-grade ore and 200 million tons of ore of lower grade as willl be clear from the following table 9·4.

Table 9·4

Known Manganese of the World*

(in million short tons)

Country	High grade Average 45%	Low grade Average 25%
India	1,000	200
Union of South Africa	50	N.A.
Morocco	30	20
Republic of Congo	10	20
Ghana	10	20
Brazil	50	N.A.
Cuba	4	8
Others	16	27

India's proportion of world production of the manganese has varied from time to time owing to the appearance of new producers. The figures of Indian manganese reserves stand as under :

Table 9·5

Manganese Reserves of India (figures in tons)

State	Reserves
Madhya Pradesh	100,000,000
Tamil Nadu & Karnataka	250,000
Orissa	100,000
Maharashtra	5,000,000

Our ores, which average 50 percent or more, are richer in manganese content than the Russian ores whose average is about 45%, Gold coast 41 to 50% and Brazil 23 to 50%. The prosperity of manganese mining is closely related to the production of steel, because the main use of the manganese ore is in that industry.

* From various sources.

TUNGSTEN

Tungsten is used in steel for high-speed cutting tools that must retain hardness up to a red heat even for long periods of time. Such steels have increased remarkably the efficiency of both machinists and lathes as may be gathered from the following quotation from American publication—"Manufactures working large groups of men say that from three to five times as much metal can be cut with such a steel as with the old simple carbon steel. In other words, under favourable conditions one man and one lathe can do as much work with high speed tungsten steels as five men and five lathes could formerly do with simple carbon steels."[1] Owing to the high prices of platinum, the use of tungsten in place of platinum points in dental work increased rapidly during the war. "The total consumption of tungsten for purposes other than steel approximated 5 tons or about 10 tons of 60 percent. Concentrates, that is, about one half of one percent of the United States' total production."[2]

Tungsten is mined mainly in United States, Korea, Bolivia, Portugal, Australia, India and Kiangsi and Kwangtung provinces of China.

Non-Ferrous or Semi-Precious Metals

Under present conditions, the non-ferrous group of metals—copper, lead, zinc and tin—must be regarded as indispensable to modern contury civilization.

COPPER

Copper is largely used for electrical purposes, mechanical, refrigerator, air conditioning apparatus, cable, telephone, radio telegraph, electric locomotive, water pipes and roofing material. Copper is also cast into bearing, bushing, lubricators, valves, and fittings ; it is alloyed with iron and nickel in the production, of stainless steel, with nickel to make 'Morel metal' and with aluminium to make duralumin ; and it enters into the manufacture of steam radiators, clocks, watches, locks and many other things. It is also used in making coins.

Next to iron, copper probably is the most useful metal. Previously to that of Broze, there was a true copper age, though possibly of not very long duration, except of course in the New world, has been established beyond reasonable doubt by recent investigations. Copper was first used for polishing stone-implements and then was associated with bronze and iron. There is a 'copper age' in human civilization which is recorded by universal history.

Despite widespread occurrence of copper ore, the bulk of it is to be found in the following areas :

1. North America

(*a*) **Western north America**—important centres are located in Arizona, Utah, Sonora, Nevada, Montana and New Mexico.

1. Frank L. Hess, U. S. G. S 1917, pp. 15—16.
2. Finck, C. G.—The Mineral Industry, p. 704, 1917.

(*b*) **Lake districts**—mostly in Michigan, wisconsin etc.

(*c*) **The Canadian Shield region**—especially in Noranda district of Quebec near the Ontario border.

(*d*) **Mid Canadian belt**—at Flin Flon in Manitoba-Saskatchewan border.

(*e*) **British Columbia**—at Allenby and Howe sound areas

(*f*) **Mexico and Cuba**—The chief mining districts of Mexico are at Cananea, Santa Rosalia and Matahambre mine at Pinar del Rio in Cuba.

2. South America

(*a*) **Chilean copper mining district**—Chuquicamata in the desert of Atacama on the slopes of the Andes, another Chilean copper mining district is found in the Southern part of the desert at Potrerillos, east of the port of Chanaral. The third district lies high in the Andes at El Teniente, in the vicinity of Sewell.

(*b*) **Peruvian mining Centres**—In Peru, there are two areas. They are Cerro de Pasco district and Toquepala in Southern Peruvian Andes.

(*c*) **Bolivian and Argentinian belt**—Copper mining is also important in the Corcoro district of Bolivia and at Famatina in the Andes of Argentina.

3. Africa

(*a*) **Congo Republic**—Katanga district of the Congo Republic into adjacent Rhodesian territory is the most important copper mining of Africa.

(*b*) **Rhodesian Copper belt**—N'kana, Mufulira and Rhokana are important copper producing centres in Rhodesian and Transvaal belt.

4. The Soviet Union

(*a*) **Uralasian Copper belt**—If the Uralasian belt is regarded as one region but production takes place in many areas such as (1) along the Southern flank of the Urals (2) at the base of Kola peninsula, (3) in the caucasus and (4) in Qara Qum region.

(*b*) **Lake Balkhash region**—Other important regions where occurrence of copper ore has recently been reported are Kounrad and Djezkazgan areas north-west of Balkhash Lake.

5. India

(*a*) In the Singhbhum district of Bihar a copper bearing belt, marked out by old workings, persists for about 144 kilometres, extending from Duarparam, on the Bajhmini river in an easterly direction through Kharsawan and Saraikela into Dhalbhum, where it curves round to South east, running through Rajdoha Matigam to Bhairagota. The important portion of this belt occurs between Rajdah and Budia. There is also a little production of Dhobani where a deposit parallel to that at Mosaboni is being opened up.

(*b*) **Himalayan Copper belt**—Copper ore has recently been reported in Sikkim, Garhwal and Kumaon. Recent work has also proved the existence of lodes of possible value in Sikkim, where the copper is associated with bismuth, antimony and tellurium. At Dikchu, about 12 kilometres to the north of Gangtok and within a kilometre of the Gangtok—Lachen road, a distance of 120 kilometres from Siliguri, a more clearly defined copper-lode was discovered by G. S. I.

(*c*) **Western Belt**—In Rajasthan copper minerals are found in irregular veins and stringers in highly deformed phylites in Khoh-Dariba area in Alwar. There is another mineralised zone of over 22 kilometres in length in Khetri area of Rajasthan.

(*d*) **Southern Belt**—In Andhra Pradesh, there are two prospective areas. They are : Agrigundal in Guntur district, fourteen kilometres north of Vinukon, and Gani in Kurnool district.

Copper Production

Mexico leads the world in copper production, furnishing 30 to 40 percent of the world's total in recent years. The second highest percentage of production is in Peru, followed by Spain, U.S.A., Republic of South Africa, Japan and Australia. The following table 9·6 shows the production of copper in some of the important countries of the world.

Table 9·6
Copper Production*

(Figures in tons)

Country	Production
Australia	169,205
Austria	195,000
Belgium	325,000
Burma	163
Canada	682,600
Ecuador	464
Federal Republic of Germany	10,000
Japan	1,128,000
Republic of Korea (S. Korea)	34,705
Mexico	63,150,000
Peru	2,140,000
Portugal	65,000
Republic of S. Africa	1,580,000
Spain	11,818,000
Sweden	51,800
U.S.A.	1,522,183

* International year book 1975.

More than eighty percent of the world's copper is mined in the countries listed in table 8·6, but to produce the remaining above 20 percent requires the combined outputs of thirty other countries.

Copper Reserves of the World

The estimated copper reserves of the world are shown for the leading nations in table 9·7. For years Chile ranked first in the world in copper reserves. Chilean copper exports are the largest in the world, and Chilean copper now supplies about 35% of the requirements of the United States. U.S. is endowed with copper reserves that apparently are surpassed only by those of the Chile. Northern Rhodesia is third.

Table 9·7

Estimated Reserves of Copper*

(millions of short tons)

Country	Reserves in short tons
Chile	46·0
United States	25·0
Northern Rhodesia	24·5
Republic of Congo	20·0
Peru	12·5
Canada	7·0
Yugoslavia	1·2
South Africa	1·1
Philippines	1·0
Australia	1·0
U.S.S.R.	16·0

India is not fortunately placed as regards the copper ore reserves since only one unit is producing copper in India. Hence we import large quantities of cooper from U.S.A., Canada, Rhodesia, Japan and Republic of Congo. This imported copper is used for high electrolytic materials, while the indigenous production is used in the manufacture of brass for utensil industry and other copper base alloys. The integrated mine and plant at Khetri under the Khetri "copper complex," which is under construction will have a capacity of 31,000 tonnes of electrolytic copper metal annually. Besides 600 tonnes of sulphuric and will be produced as a by product which will be utilized for the production at about 200,000 tonnes of triple super phosphate per annum.

ZINC

The largest use of zinc in the world is in the manufacture of galvanized iron sheets. Zinc is a mixed ore containing lead and zinc. Its chief ore is zinc sulphide. But it is also obtainedfrom calemine, zincite, wilemite and hemi-morphite.

*The International year book 1974 or U.S. Bureau of Mines.

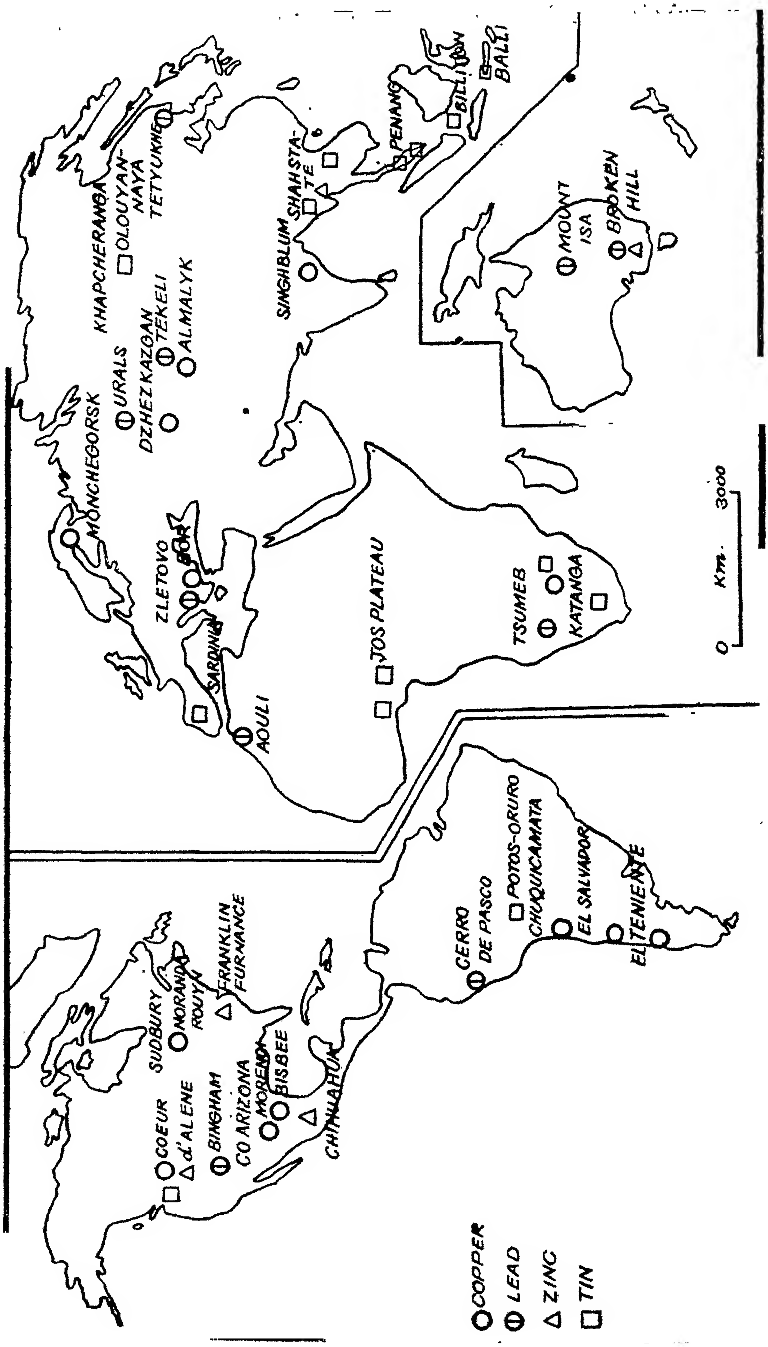


Fig. 98. Non-Ferrous Metals

In India the known resources of zinc ore are rather limited as there is only one commercially exploitable deposit in Zawar near Udaipur in Rajasthan. It is being worked by Minerals and Metal Corporation of India, Ltd. Attention should also be paid to the occurrence of zinc in the Hazaribagh district of Bihar.

For many years the United States led the world in output of zinc. More than half of all zinc in U.S. is mined in five districts—(1) The tri-state district of Missouri, Kansas and Oklahoma, (2) Coeur d'Alene of Idaho, (3) Butte in Montana, (4) Franklin in New Jersey and (5) St. Lawrence country of New York.

The leading mining centres in Canada are sullivan and the Reeves—Mac Donald mines at Kimberley, Buchans in Newfoundland, Quebec and Yukon territories.

In Mexico zinc has long been mined in San Luis Potosi, Zacatecas, Chihuahua and other states.

In Europe, principal zinc producers are west Germany, Poland Italy and Spain etc.

In the Soviet Union three fourths of all zinc is mined near Leninogorsk in the Altai Mountains of Kazakhstan, the remainder being produced in such widely scattered districts as the Caucasus, Urals, lake Balkhash and Vladivostok. Fig. 9·8 shows the distribution of non-Ferrous metals of the world.

In Australia, the leading mining centres are Broken Hill in New South Wales, Mount Isa in Queensland, and Rosebery in western Tasmania.

ALUMINIUM

Within the period of three or four decades, aluminium has come to the forefront as an important metal. On account of its remarkabe properties such as lightness, high thermal and electrical conductivity and resistance to corrosion, the use of aluminium are daily growing in number and importance. Its most important and largest use today is in the building of aircraft. It is also being used in the manufacture of domestic utensils, railway carriages, motor cars, furniture storage receptacles for liquids, as powder or paste in the paint industry, for cables in electrical transmission lines. A large quantity is also being used for portable, semiportable or prefabricated houses. It is because of these multifarious uses that the world production of aluminium which was merely 6,76,123 tons in 1939 has been rapidly increasing till it now reached the peak of about 50 lakh tons and the largest increase in production has taken place in the U.S.A. and Canada accounting for more than 50% of the world output.

Bauxite is the ore for aluminium and it is one of the most commonly found elements. Yet it takes its name from a small village in Southern France, Les Bauz. Unknown before the 19th century, Bauxite shot into prominence and became one of the most sought after ores, because many uses of Aluminium were being discovered late in the 20th century.

France was the first country where Bauxite was discovered. There were many other countries in which the Bauxite is found. But the secret of smelting it, of obtaining Aluminium from it, remained only with one or two European Nations. U.S.A. soon got into the industry of manufacturing Aluminium from Bauxite and while the European Nations were busy fighting World War I, U.S.A. collected Bauxite from as many countries as possible for turning it into aluminium.

During the war, aluminium came to be looked upon as the most favoured metal for defence purposes. No efforts were spared to investigate into the many possibilities of utilizing the bright, light, white metal for establishing superiority on the field of battle. While the war Department carried out the costly and laborious research, the uses of aluminium in civil life jumped forward by leaps and bounds after the war came to an end. It would be right to say that the initiative taken for fulfilling Military requirements, was later found more useful in civilian life.

Search after Bauxite by Great Britain, brought to light deposits in India as early as in 1905. They were worked and Bauxite exported to UK only in 1908.

There are some quite promising places for the discovery of Bauxite deposits; they are the concave portions of searpts in the Deccan hills; usually, the upper three to ten metres and the beds of streams on the bigger plateau, are favourable "hunting grounds". Here the deposits of Bauxite–cream–coloured in appearance often occur below a thin covering of highly ferruginous laterite. Presence of lithomarge on flat topped laterite hills is considered a favourable sign for the presence of Bauxite deposits.

The list of districts in which Bauxite occurs will be quite long and elaborate; Palamau and Ranchi in Bihar, Belgaum, Dharwar and Mysore in Karnataka State, Kolhapur, Thana in Maharashtra, Rewa, Jabalpur, Katni, Balaghat and Bilaspur in Madhya Pradesh, Kalahandi and Visakhapatnam in Orissa, Salen in Tamil Nadu, Mirzapur in U P. are important locaties.

The main producing deposits are in United States, British Guiana, Haiti and Dominican Republic, Jamaica, Surinam, Gold coast, Brazil, Yugoslavia, France, Greece etc. In Australia. at Weipa, on the western shore of Cape York peninsula, and at Gove, on the northeast tip of Arnhem Land, are large proved reserves of Bauxite.

LEAD

After iron, it is the most commonly used mineral due to its lightness, softness and maleability. As a metal, an alloying agent, an ingredient of manufactured goods, and an agent in industrial operations, the range of lead's usefulness is about as wide as the field of industry itself. It is present in the paint, plumping materials, glass-ware and musical instrument, in transportation,

large quantities are required in the manufacture of automobiles, airplanes, locomotives, batteries and electrical appratus and wires.

The important ore of lead is *Galena* (Sulphide of lead) which contains about 86% of the metallic lead. Other lead ores are cerusite (which is carbonate of lead) which contains about 77% of the metallic content and Angestite (the sulphate of lead) in which the metal content is 68%.

Although a number of occurrences of lead have been reported as scattered in places like Hazaribagh in Bihar, Gwalior, Datia and Drug in Madhya Pradesh, Udaipur and Jaipur in Rajasthan, the only Commercially workable deposits are in the Zawar mines near Udaipur in Rajasthan.

Australia had the largest output, followed by the Soviet Union, the United States, Mexico and Canada.

TIN

Tin is of great use and is very largely employed in a number of uses. "It accompanies man in every walk of life literally from cradle to grave. It is a necessary ingredient of a soldier, and is a component of habit and most other anti-friction metals, without which manufacture and transportation would be impossible. As foil, it warps alike the workman's tobacco and the school girl's confections. It accounts for rustle and lustre of silk so dear to feminine heart, while the tin dinner pail has a place in politics and is celeborated in song and story. Without humble tin can, the world could no longer be properly fed."

Tin ore occurs in the mineral casseterite found in granitic rocks and occurrences were noted in Hazaribagh, Gaya and Ranchi districts in Bihar. Small amounts of tin ore are found associated with granite and pegmatite at Chaptand, Senirated and Chakkar-Bondha.

The leading tin-producing region of the world is Southeast Asia, which includes the Southern part of the Malay Peninsula, the Indonesian islands of Bali, Bangka and Billiton and Singkep and parts of Tha iland, Burma and China. Nigeria, Congo Republic, Bolivia and Soviet Union are important tin-producing centres lies outside Southeast Asia.

For century South east Asia has been famous for its tin production. In Malaya Peninsula, most of the tin ore is obtained from the States of Perak, Selangor, Negri Sembilan, Kanta valley Pahang. The tin mines of Indonesia are located on the little islands of Banka, Bali, Billiton and Singkep.

In China, mining occurs in the provinces of Yunan, Kwangsi and Hunan.

In Burma, the best-known centres are Karathuri on the coast and Thabawleik on the Little Tenasserim river. On spider island, at the mouth of the Palauk river, is an interesting area in which

concentrates containing cassiterite and wolfram in about equal amounts are obtained from the sea beach and from below high water level in a mangrove swamp. Cassiterite occurs occasionally in Southern Shan states, Thaton, Amherst and Tavoy distrcits of Burma.

Bolivia is the only tin-producing country in the western Hemisphere. Its ore occur in lodes that are scattered throughout the Cordillera Real, or eastern range of the Andes. Most of the tin ore is obtained from the districts of Llallagua-Uncia-Huanuni, Catavi, Colquiri etc.

In Soviet Union there are four well-marked belts of tin deposits : (1) in the Onon River valley east of Lake Baikal, (2) near Verkhoyansk in northeastern Siberia, (3) near Tetyukhe on the sea of Japan, about 320 kilometres north of Vladivostok, and (4) in the Peikhankai Depression in the far east.

ANTIMONY

Antimony is a useful alloy for mixing with soften metals. In India antimony deposits are found in Lahul and Kangra district of Himachal Pradesh. A considerable quantity may also be obtained from the Chitaldrug district of Karnataka State.

China led the world in antimony production. Others important producers are Algeria, Czechoslovakia, Yugoslavia, Mexico and Latin American countries.

PRECIOUS METALS

A small group of metals, particularly gold, silver and platinum were highly prized for ornaments and coins even before the dawn of recorded history.

GOLD

India is very poor in precious ores. Silver is entirely absent, while only a small amount of gold occurs in a corner of the Deccan tableland. Practically all the gold mined in India comes from the Kolar fields in Karnataka. In the Kolar field there is a single vein or reef averaging only one metre in thickness in which gold occurs for a distance of about eight kilometres. There are four mining centres in the State, *viz.*, Nandydroog, Mysore, Oregaum and Champion reef. The deepest mines are Champion reef and Oregaum which have each reached a depth of considerably over 2743 metres measured vertically.

Gold bearing viens are also known to exist in Dharwar district of Karnataka, Wynnad and Anantpur districts of Andhra Pradesh and Lava in Manbhum of Bihar. Alluvium gold is also washed from the sand of the rivers of Assam, U.P. and Orissa.

Most of the world's supply comes from the Union of South Africa, the United States, the Soviet Union and Alaska.

SILVER

Silver is always mined in conjunction with copper, lead, zinc and other metals. Mexico is the leading silver producer country of the world. In Mexico the important deposits are situated in Pachuca. Other important silver mines are located near the towns

of Chihuahua, San Francisco del oro, Parral, and Santa Barbara in the State of Chihuahua, at Fresnillo and Mazpil in Zacatecas, and at Sierra Mojada in Coahuila.

Next to Mexico, United States contains the most extensive deposits of Silver in Idaho, Montana, Utah and Arizona.

Canada, the third leading producer, gets most of its silver from British Columbia and the remainder from Ontario and Quebec provinces.

Most Australian silver is mined in the Broken Hill district of western New South Wales and Mount Isa district near Cloncurry in Queensland. Other silver-mining countries of lesser economic importance are the Soviet Union, Bolivia, Peru, the Congo Republic and Japan etc.

PLATINUM

Large deposits of Platinum, which is used in the manufacture of Sulphuric and nitric acids, high octane gasoline, and in many chemical industries are known to occur in a number of places in Canada, the Union of South Africa, the Soviet Union, Alaska and Colombia.

ATOMIC ENERGY MINERALS

Atomic minerals are indispensable for the most important activities having to do with defence. So that these minerals are also known "Strategic minerals." Their importance have so increased with the development of Jet aircraft, gas turbines, rockets, atomic energy and electronics that fully 75% of all alloys include these minerals. Of these, uranium, thorium, vanadium and molybdenum are by far the most important.

Uranium

Uranium is used principally for weapons production and as fuel for power, propulsion and irradiation reactors.

The chief deposits are in Rajasthan, Kerala, Bihar and Tamil Nadu. Of these, the chief producing centres are Trivandrum and Gaya. The Tarapur nuclear power plant built 99 kilometres north of Bombay generating 380 megawatts.

Canada has also planned to build India's second nuclear power plant, a 200 megawatts, "Candu-Type" station at Rana Pratap Sagar.

Uranium is also used for chemical, electronic, and surgical equipment, and for cutting tools and dies. Uranium is mined mainly in Canada, the United States, the Soviet Union and the Union of South Africa.

Thorium

Thorium is mostly used in magnesium alloys and gas mantles. Magnesium containing up to 3 percent of thorium retains a much higher strength between 120° and 140°C. The popularity of thorium alloys increased during 1963 and the Atomic Energy Commission (A.E.C.) proposed amending its regulations to exempt such alloys from licensing.

Significant amounts of thorium were also used as refractories, and in chemical products and electronics. Thorium was used as a reactor fuel for research and developments facilities.

Power plant proto-type reactors using thorium presently in operation or in an advanced stage of construction are—

1. Apsara, India's first reseorch reactor, the firist reactor in Asia outside the U.S.S.R.

2. I.C.R. or the Canadian India Reactor—is India's second reactor, being a joint Indo-Canadian Project under the Colombo plan.

3. Zerlina is India's third research reactor.

4. Extension of the Rana Pratap nuclear station by 200mw. and the establishment of the next nuclear station of 400 mw. capacity at Kalpakkam in Tamil Nadu have been sanctioned under the 4th and 5th Plans.

The United States, Brazil, Nigeria, the Soviet Union and the Union of S. Africa are important thorium producing countries of the world.

Vanadium

It is an atomic energy mineral. Reserves of vanadium exist in the States of Orissa, Bihar, Kerala and Andhra Pradesh. The chief producing centres are Gaya, Mayurbhanj, Hazaribagh and Nellore.

Vanadium is widely distributed all over the world, but commercial deposits are restricted to Northern Rhodesia, the United States, Peru and South west African countries.

PART IV

POWER RESOURCES

CHAPTER 10

THE MINERAL FUELS

The main sources of mineral fuels are coal and petroleum. These two mineral fuels have become the main-springs in our industrial world—"the keys to national supremacy".

Man's Relation to Mineral Fuels

Coal is the basic fuel required for almost all industries and its importance in the industrial development and economic advancement of the country needs no reiteration. Moreover, a large and rich variety of by-products are obtained from carbonisation of coal and these form the essential raw materials for a multitude of chemical industries.

Over thousands products derived from coal. The main by-products of coal are Benzol, Ammonia, Tar, Naphthalene, Phenol, Toluol, Carbon papers, Bicycle lamps, tobacco pouches, Facial cream aromas, Shaving cream aromas, plastic pictureframes, Vanity cases, Hair Pomade aromas, book ends, movie screens, waterproof paper, Colour films, Candy flavors, lipstick colours, play shoes, radio cabinets, Synthetic quine, acetanilide, phenolphthalein, suefathiazole, safty glass interliner, Benzoic acid, plastic safety razors, Synthetic musk, rubber mattresses, mercurochrome, industrial gas, refrigerator enamel, bathing suits, rubber sponges, belts, Drapery materials, Hot water bottles, rubber tubing, pencil sharpeners, pencil erasers, synthetic rope, rubber heels, fireproof furniture, Nylon stockings, perfumes, industrial steel. Coat hangers, Aeroplane fittings, poker chips, phonograph records. raincoats, typewriter ribbons, lingerie, ammonia water, Cigarette holders, tooth brushes, compacts, coloured plastic tiles, belt buckles, electric switches, Camera cases, Novocaine, plywood boats, parachutes, knife handles, Hat Trimmings, soap dishes, paint pigments, saccharin, Violin strings, Battery boxes etc.

As coal is by far the most important and cheapest fuel, it goes without saying, therefore, that the modern industrial development cannot take place without coal. Coal is black industrial diamond upon which our present civilization depends to an amazing degree. Coal is needed for manufacturing armaments, ammunitions and munitions, battleships, tanks, guns, machine guns, bombs and shells, which must be manufactured for the modern war and various types of heavy machines. Finished products must then be transported from the factory to the field where they will be needed by the soldiers.

Coal is the key to many chemical operations, as well as the major source of heat or power. Partial alternative may be found

in oil and gas or in water power, but coal remains supreme. The importance of coal in the world of today can scarcely be over-emphasized, for as one authority observes, "of all the resources which are basal to our existing civilization the possession and utilization of coal must be placed first."[1]

Coal is the basis of our modern machine civilization, because of its suitability for raising steam, smelting ores, and providing heat. In short, coal is the attracting magnet. Coal is the most important source of power for commercial energy. It is by far the leading source of inanimate energy in France, Poland and Soviet Union. The industrially advanced countries, such as the United States, the Soviet Union, Great Britain, Germany and France together consume about three-fourths of the world's annual supply of coal. It is the source of more than 90% of all fuel and power produced in Great Britain, Germany, Belgium—Luxembourg and Czechoslovakia.

Types of Coal

All coal may be divided into three varieties on the basis of carbon content :

Lignite : Lignite burns with much smoke and flame. It is often called brown coal, has the lowest carbon content (about 45%) and the highest water content. About half of the world's lignite is mined in Germany. It is also an important raw material for German chemical industries.

Bituminous : It contains a higher percentage of carbon (70 to 75%) and less water and oxygen than lignite. Bituminous coals are subdivided into coking and non-coking coals and each one of them in turn into gas coal and steam coal.

Anthracite Coal : It is extremely hard, and has a brilliant black lustre that contains 80 to 90% carbon and practically no smoke or flame. Among the nations of the world, only China and the United States have appreciable deposits of anthracite. It is estimated that the total reserves of all kinds of coal in the world amount to about 4,640,561 million of metric tons.

The National Coal Association[2], Washington D.C. (1970) estimated the quality of good quality coal at 3,863,626 million metric tons, while Dorothy and others[3] in 1953 placed this figure at 4,154,661 million of metric tons. The National Coal Association, Washington, estimated the Reserves of the world as follows :—

1. Edward Charles, Jeffrey—Coal and Civilization, p. 2.
2. National Coal Association, Washington, 1970.
3 Paul Averitt, Louise R. Berryhill and Dorothy A. Taylor—Coal Resources of the United States, circular 293, 1953.

Table 10·1
Estimated World Coal Reserves 1970
(in million of metric tons)

Country	Anthracite bituminous	Lignite and brown coal	Total	Percent Region Total	Percent World Total
Soviet Union	998,000	202,000	1,200,000	52·4	25·9
China	1,011,000	600	1,011,600	44·1	21·8
India	62,427	508	62,935	2·8	1·4
Japan	9,897	258	10,155	·4	·2
Others	4,711	3,808	8,519	·3	·1
Asia Total	**2,086,035**	**207,174**	**2,293,209**	**100·0**	**49·4**
U.S.A.	1,099,906	405,970	1,505,876	94·1	32·4
Canada	62,472	24,450	86,928	5·6	1·9
Mexico	4,306	—	4,306	·3	·1
N. America	**1,166,684**	**430,420**	**1,597,104**	**100·0**	**34·4**
Germany	224,300	62,000	286,300	47·5	6·2
U.K.	170,686	—	170,686	28·3	3·7
Poland	80,000	18	80,018	13·3	1·7
Czechoslovakia	6,450	12,500	18,950	3·1	·4
France	12,288	430	12,718	2·1	·3
Belgium	5,988	—	5,988	1·0	·1
Netherlands	3,400	—	3,400	·6	·1
Others	2,622	22,154	24,776	4·1	·5
Europe	**505,734**	**91,102**	**602,836**	**100·0**	**13·0**
Republic of S. Africa	68,000	—	68,000	97·4	1·5
Others	1,650	200	1,850	2·6	—
Africa	**69,650**	**200**	**69,850**	**100·0**	**1·5**
Colombia	12,000	—	12,000	63·6	01·3
Venezuela	3,068	—	3,068	16·2	—
Others	3,556	254	3,810	20·2	0·1
S. America	**18,624**	**254**	**18,878**	**100·0**	**0·4**
Australia	**16,899**	**41,785**	**58,684**	**100·0**	**1·3**
World Total	**3,863,626**	**776,935**	**4,640,561**	**—**	**100·0**

WORLD DISTRIBUTION OF COAL RESOURCES

The chief coal producing countries of the world in 1970 were the United States, Great Britain, the Soviet Union, Germany, France, Poland, Japan, China and India. In that year these countries together produced about 80% of the world's estimated total production of nearly 13000 millions metric tons. The production of coal in United States during 1970 was 4,475 million metric tons; that is 32·4% of the world's total production. The second highest percentage of coal production in the world was in the Soviet Union about 25%, followed by China 21·8%, Germany 6%, U.K. 3%, Poland and India 1% each.

The United States and Canada.

The coalfields of the United States can be grouped into eight categories. They are as follows :

1. The Anthracite Basins

The anthracite coal field covers an area of about 1248 square kilometres, most of it within eastern Pennsylvania, but stretching also across the boundaries into New York and New Jersey. The chief mining centres are Wilkes-Barre, Scranton, Pottsvill and Shamokin. The Anthracite coal field is also known as the eastern Pennsylvania coal field.

2. The Appalachian Coal fields

This coal field fall into three groups —

(*a*) *North Appalachian field*—Pittsburgh is the most important mining centre in north Appalachian coal field. The Pittsburgh coal field has an area of about 12000 square km. with many workable seams, 2 to 4 metres thick.

(*b*) *The central Appalachian coalfields*—Coalfields of middle Appalachiana include west Virginia, eastern Kentucky and Tennessee The central Appalachian coalfields have several fairly thick seams.

(*c*) *Southern Appalachian*—The southern most of these Appalachian coal fields is in Alabama near Birmingham. This coal field and the nearby deposits of iron ore and limestone are the basis of Birmingham's steel industry.

3. Eastern Interior coalfields

About 18% of the United States total bituminous output, which exceeds 83 million tons is obtained from Eastern Interior coal fields. The coal, bituminous, is not as good quality as that of the Appalachina fields, but it is useful for steam and domestic purposes.

4. Northern Interior coal fields

Michigan state is now the centre of coal mining in the Interior province, but Chicago remains the organizing centre of the Iron and Steel industry, not only of the Lake Superior region but of North America as a whole. Gary is another iron and steel town in Michigan coal fields.

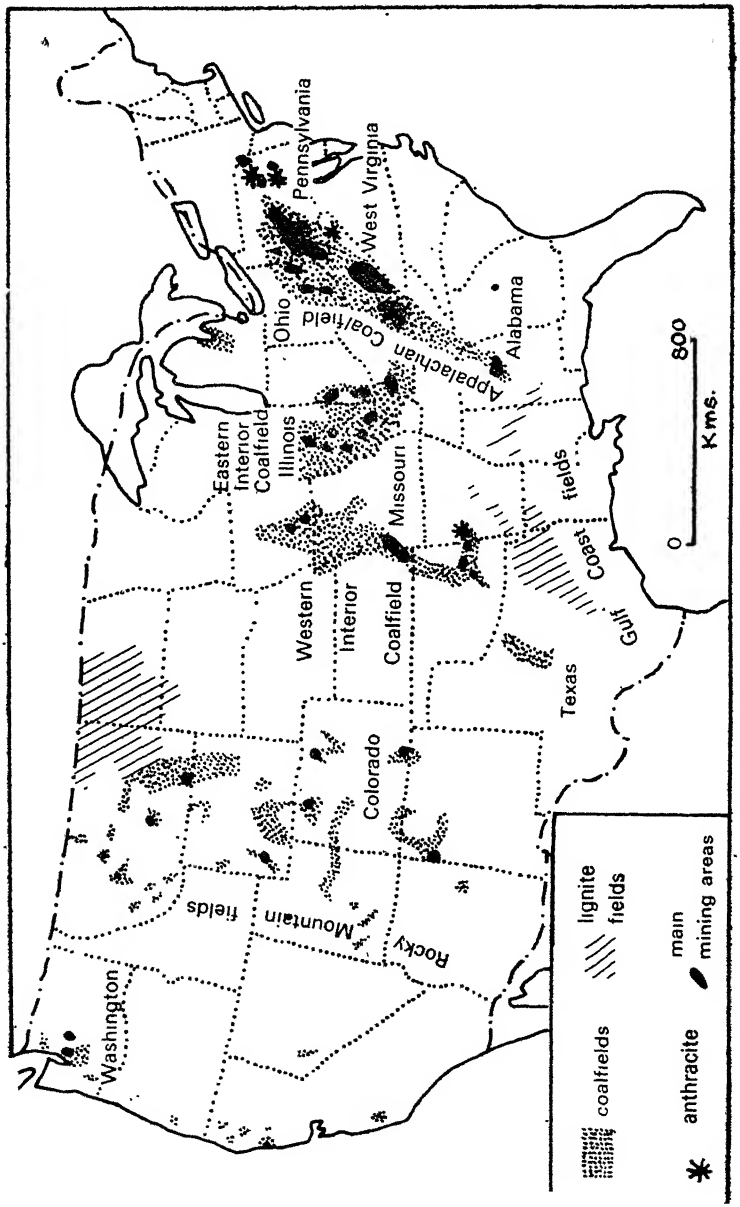


Fig. 10·1. Coal fields of North America

5. Western Interior coal fields

This field, like its counterpart, the Eastern Interior field across the Mississippi, has important coal deposits of bituminous and Sub-bituminous. The coal is below average in quality. The principal coalfields being worked in western Interior are Arkansas, Oklahoma, Kansas, Missouri, Eastern Nebraska and south western Iowa. These fields possess about two-thirds of the United States total reserves, but they produce only 8% of the nation's coal.

6. Southern Interior coalfields

The southern Interior field is of little importance even locally because of the poor quality. Southern interior is the extension of western Interior field in Texas. In the western interior and south western fields extending from Central Iowa to Central Texas are beds of bituminous coal that out crop along the eastern margin, where small quantities are mined for local consumption. It is traversed by the Mississippi and its tributaries, in the bed of which the coal crops out in numerous places. Fig. 9·1 shows the distribution of coal producing centres of North America.

7. Rocky Mountain

The Rockies are noted for their mineral wealth, and the chief towns here are mining centres. Besides coal, mainly lignitic in character, which occurs in various scattered areas, and is as yet little worked, there are valuable deposits of bituminous and sub-bituminous. The reserves of the Rocky mountain province are enormous, but actual production is small. Only two-thirds of the United States coal comes from western fields, along the eastern rim of Rockies in Colorado, Wyoming, Idaho, Arizona, Utah and Montana.

8. Pacific Coast coalfields.

In the extreme far west of the United States between Sierra Nevada and Ellenburg in California Oregon and Washington, are the most extensive field, covering more than 2000 km² and producing low grade coal that is transported to Vancouver for the bunkering of ships.

Much of Matanuska, Bering River and Arctic slopes of Alaska is underlaid by coal measures, but exploitation has hardly yet begun.

More than 90 percent of Canada's coal is to be found in the west, over half in Alberta alone. Much occurs also in Saskatche wan and British Columbia; and a small amount is found in the Maritime provinces, particularly in Nova Scotia and New Brunswick. Canada imported much of her coal from the United States.

The Canadian coal is of poor quality. It contains very high percentages of ash and sulphur, is of low heating power, and is unsuitable for smelting purposes. It is not, therefore, surprising that the domestic consumption of coal in Canada is much, amounting to over 15 million tons a year.

South America

With only 0 3 percent of the world's coal reserves, South America ranks among the poorest of the continents. Rich in almost every other mineral, South America is poorly provided with coal deposits. Those which have so far been discovered are few and yield fuels of inferior quality.

Colombia has the largest reserves in Latin America. Most of the coal lies in two areas (1) northeast of Bogota where the Paz del Rio steelworks are situated and (2) in the valley of the Cauca near Cali.

Coal is well distributed in Peru. The two principal producing areas are (1) Oyon, west of Cerro de Pasco in the Sierra and (2) the Santa valley. Coal is also found in Rio Bonito beds of the Tuberao series of Brazil. This, the only coal in Brazil, occurs in the Rio Bonito beds of the Tuberao series which crop out in a band about 20 kilometres in width, in two stretches—first, from Itapetininga in Sao Paulo, approximately along the route of the Rio Grande railway via Boa Vista in Parana, into Santa Catarina ; and Second, in Rio Grande do Sul, from S. Jeronimo near Porto Alegre to Jaguarao close to Lake Mirim. Of these two series, that in Rio Grande do Sul has the advantage of convenient situation with regard to water transport, but the annual output from it is rather smaller than the million, odd tons from the Santa catarina deposits.

Coal-mining in Chile is confined to the provinces of Arauco, Concepcion and Valdivia, and to a small district near Magellanes. The deposits are neither extensive in area nor contain any great reserves. Bulk of the coal produced, at present amounting in all to about 2 million tons a year, comes from the Corcnel and Lota districts on the coast near Concepcion. Unfortunately the coal, though fairly satisfactory for raising steam and for domestic use, is of poor coking quality, and has to be mixed with imported coal in smelting works, especially in the new iron and steel plant near Talcahuano.

Coal Resources of Europe and England

The total European resources of coal were estimated at 602,836 million metric tons in 1970. Great Britain's share in these reserves works out to more than 3·7 percent of the whole world.

Britain is very richly endowed in fuel Resources. Apart from reserves of Nickel, she possesses good resources of coal and alloy minerals. The most important mining area is the region comprising the eastern and western rims of the Pennines. The Pennines were formed long ago by an upfold of Carboniferous rocks, but the coal which was then all over the top has been worn away, till now it is only found on the flanks—*i.e.*, the coal-fields of Northumberland, Durham, Yorkshire and Lancashire. Underneath this was a layer of millstone grit, which, though much worn away in places, still caps the higher peaks, and is largely found in the

middle of the range. Below this, and now often at the surface, is grey carboniferous limestone.

In England and Wales an exposed coalfield is an out crop of Coal Measures of upper Carboniferous age, and a concealed coalfield is one wherein the Coal Measures are buried beneath an unconformable cover or overburden of Permian or Mesozoic rocks. In England and Wales all coal fields are basins or broadly synclinal structures, the Coal Measures resting more or less conformably upon the Millstone Grit or unconformably on Lower carboniferous or older rocks. Some of them, like the South Wales coalfield, are wholly exposed; other, as the Yorkshire field, where the eastern portion of the basin disappears under a progressively thickening wedge of newer strata, are partly exposed and partly concealed; some, again, like the Kent or Dover coalfield, are entirely concealed. The chief coal-fields are :—

1. The Yorkshire, Derby and Nottingham Coalfield

The most important is the York–Derby–Notts coalfield, a eastern continuation of Lancashire field. It is situated along the eastern flanks of Pennine Hills, and produces about 60–70 million tons of coal a year, that is, 69% of Britain's total production. Considered as one unit this East Pennine coalfield lies within an oval 100 kilometres long between Leeds and Nottingham, and more than 70 kilometres broad from Sheffield to the Humber. It is the largest, perhaps the richest and certainly now the most prosperous of British Coalfields. The Yorkshire and Derby are the British's main present supply and reserve of gas coal and of the kinds of coal required at coke-ovens which feed blast-furnaces. Where modern coke-ovens alongside colliries are near to towns, their gas is conveniently 'gridded' and distributed for domestic and industrial service; where the iron and steel industry is located near the ironfield, the coke is fed to blast-furnaces and the gas applied for the conversion of iron into steel.

2. Northumberland and Durham Coalfield

This field, which ranks second in output among those of Britain, is eminently well located for making coke for supplying the requirements of much of the iron and steel industry of the north eastern coast. Although the Tyne and other valleys which open to the north-east coast have been sending Sea coal to London since the fourteenth century, the Northern coalfield continues to mine some 40 million tons of coal per year from a score of different seams. The area is mostly exposed coalfield, and none of the pits is very deep. East of Durham, there is cover of Mangnesian limestone, which is heavily watered near the coast, and under it the seams are rising to outcrop a few kilometres out to sea. Northumberland coals are free-burning house and steam coals.

3. Lancashire Coalfield

The output from Lancashire with Cheshire is about 15 million

tons. These, and the seried row of Midland coalfields—Shrewsbury, Coalbrookdale, Cannock, the Black country, war—Wickshire and Leicestershire—are together about as productive as Lancashire. They all are parts of the once continuous depositional sheet which overspread the southern Pennines. Coals in the places of deepest settlement attained the rank of coking coal. Of the total production of coal about one-fourth is used by the railways and the rest by industries. The coal present here gave rise to important industrialization.

4. Cumberland Coalfield

In Cumberland, in the Midlands and in south-west England shales, marls and red sandstones occur with bandes of scree-breccia and conglomerate. They appear to be mainly Permian in age, but follow conformably upon thick beds of red upper Coal Measures. The ports of Workington and Whitehaven are the outlets for the small Cumberland coal-field. More important than this coal is, however, the large supply of iron mined between Workington and Morecambe Bay. The Furness peninsula is particularly rich in red hematite iron—a kind that does not always require limestone to smelt it. The iron industry has led to shipbuilding at Barrow where a fine artificial harbour has been created.

5. North and south Staffordshire Coalfields

Located near the southern end of the Pennine Mountains, the staffordshire coalfied is a example of inland coal-field. Coal seams are deep and the coal is comparatively low quality.

The coal of Northern Staffordshire is used in manufacturing earthenware at stocke-upon Trent, Hanley, and other towns in the vicinity, as suitable clay exists there. In northern Staffordshire the potteries at stocke use local coal, so that known as the Potteries coalfield. The towns also manufacture China, but the Kaolin, or decomposed granite, used for this has to be brought from Devon and Cornwall. Stafford, a little south of this district, manufactures boots and shoes.

The coal from the fields of south Staffordshire and North Warwickshire is mainly devoted to the manufacture of iron goods, though nearly all the iron used to be imported. This district is sometimes called the Black country, on account of the piles of cinders, the smoke from the great furnaces, which are kept burning night and day, and the lack of vegetation. Several coalfields lie Trent basin and support many industries.

6. Wales Coalfields

The coal field is 96 kilometres long and its pits are now here more than 48 kilometres from the shipping ports of Newport, Cardift and Swansea on the Bristol channel. The produce of western district, about one-sixth of the whole, is the world-famous low-ash anthracite. This coalfield includes two areas or fields—

(*a*) **North wales coalfield**

The North wales mountains, which form a roughly rectangular upland region, consist of very old rocks. The oldest rocks occur in the projceting countries of Carnarvon and Pembroke, while in the South theré exists a great coal-field, and a small one in the north-east round Flint and Wrexham.

(*b*) **South wales coalfields**

The rich coal field which occupies much of west Monmouth, North Glamorgan, and South Carmarthen, affords employment to a large number of the inhabitants, and though iron ore has now to be imported, mainly from Spain, as the local supply is comparatively little worked, there are great smelting works in the district.

7. Scottish Coalfields

The half-dozen separated Scottish coalfields taken together now produce almost as much fuel as does South wales. Coal from the shallow coalfields of the west (Ayrshire) and central (Lanarkshire) area is mainly from upper Carboniferous coals of similar age to those of England. Towards the east, especially in Fife and the Lothians (connected under the waters of the Fife and Forth) the Edge coal series of Lower Carboniferous age holds larger reserves of coal, and while the central coalfield is still the most productive area, the large deep pits of Fife and the Lothians are increasing in importance. Some of the coal is suitable for making coke but generally poor in quality. There are also small coalfields in Kent, in Ireland and in Gloucestershire in Bristol. Fig. 10·2 shows the coal resource of U.K.

CONTINENTAL EUROPE

The coal reserves of continental Europe is estimated at 602,836 million metric tons, though compared to some other industrialized countries they can not be considered abundant. The total world reserves of coal were estimated at 4,640,561 million metric tons. European's share in these reserves works out to less than 14 percent The important coalfields are :

Westphalian Coalfield

This coalfield, the greatest in Europe, forms one vast industrial area stretching from the Rhine ports of Dusseldorf and Duisburg eastward through the Ruhr valley to Dortmund. The great resources of the Ruhr is its coal, known reserves of which have been estimated at about 55,000 million metric tons to a depth of 1,000 metres. To a depth of 2,000 metres the known and probable reserves rise to 213,600 million tons—by far the greatest coal deposit in Europe.

There are three main uses of coal. It is made into briquettes for domestic fuel, fed row into furnaces for the generation of electricity, and can be used in the chemical industry to produce tar and lubricating or fuel oils. Generating stations use about a third of the tolal output—over 80 million tons a year—to produce nearly a third of west Germany's electricity requirements.

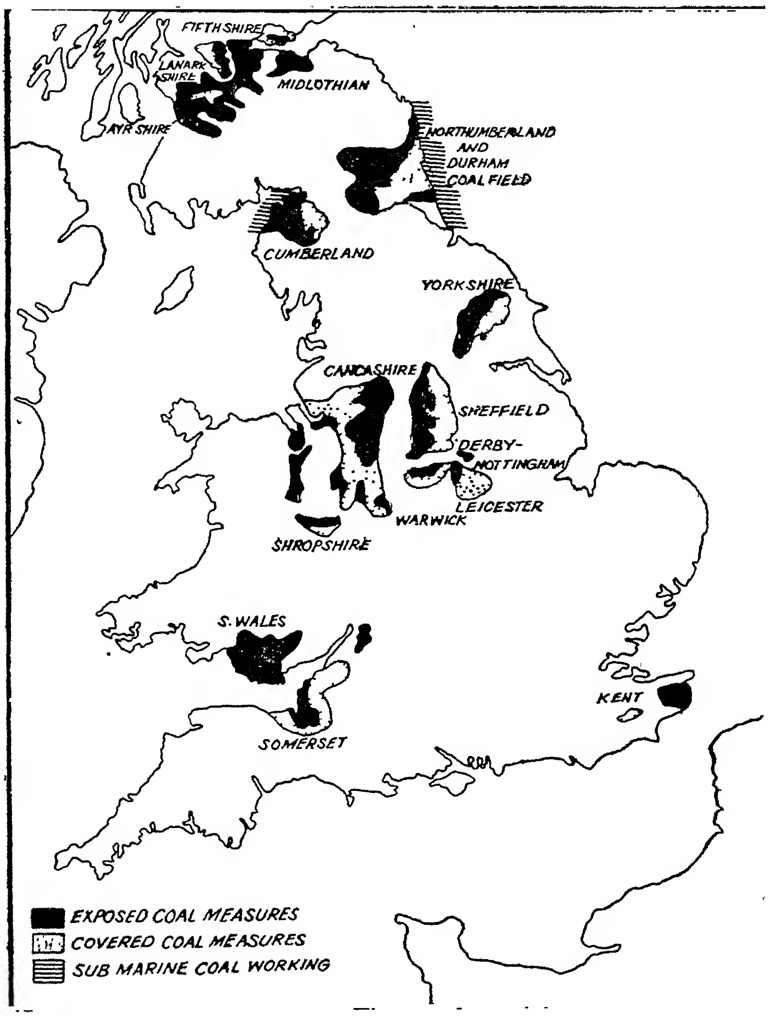


Fig. 10·2. Coal fields of U K

As the coal is the best in continental Europe for coking purposes, much is sent to feed the blast furnaces of Lorraine and Luxembourg, from whose mines ore is dispatched to iron and steel works at Essen and other Ruhr towns. Much coal is shipped to other parts of Germany by the Dortmund—Ems canal, which provides a link with the Rhine river and also with the Midland canal running to the Elbe.

The Saar Coalfield

The Saarland is a hilly country with poor soils, covered to one-

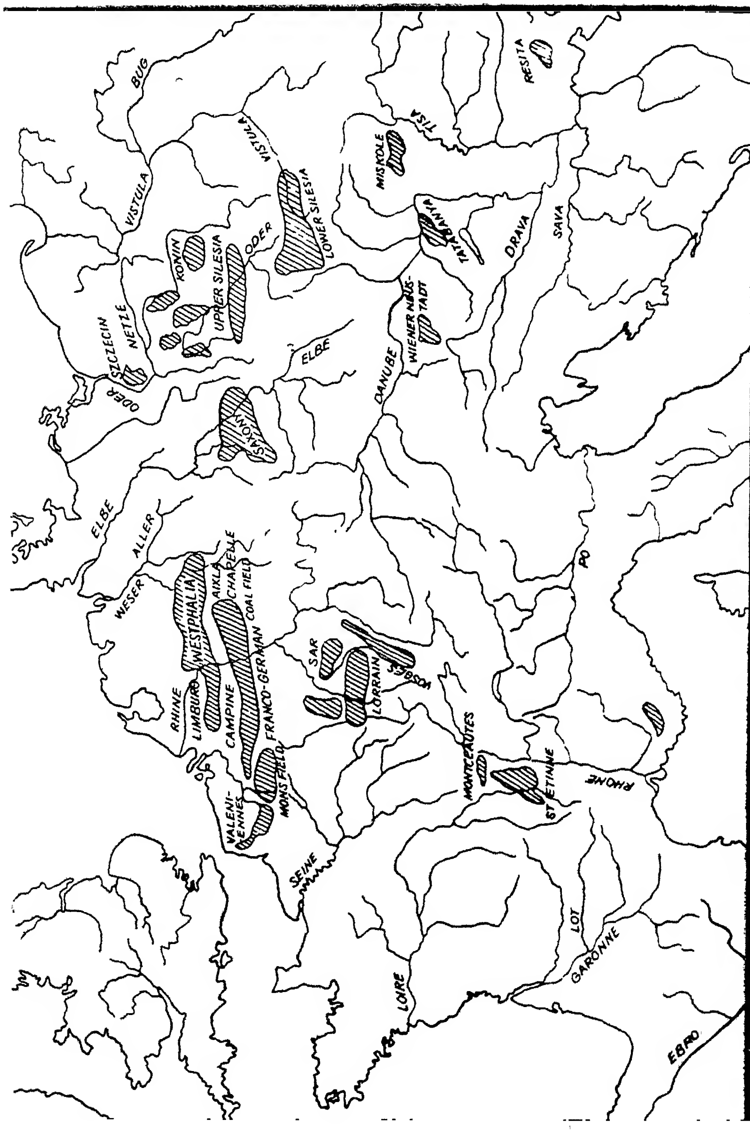


Fig. 10.3 Coal fields of Europe

third of its area with forests. Its chief value lies in its coal deposits. Most of it is good coking coal, valuable for smelting. The saar is a centre of heavy industries and diversified metal goods manufacturing.

Saxony Coalfield

On the Saxony coalfield there are iron and steel works, supplied with local ore. The great asset of the region is in the enormous deposits of lignite around Leipzig and Hall and as far north as Bitterfeld, although the enormous potash and salt deposits also play an important role in the chemical industry. As a result of the contiguity of the lignite and the potash and salt deposits, the region has become a great chemical producing area.

Franco-Belgian Coalfield

This long narrow coalfield, extending 160 kilometres along the northern flanks of the Ardennes and rarely more than 10 kilometres wide, is the most highly industrialize region of Belgium. Most of the thicker seams have been worked out, and thin seams are uneconomic, for they are difficult the mechanise and expensive to exploit. Yet in spite of that, the coalfield produces two-thirds of Belgium's coal and is still at present the chief factor in the country's industrial output. Franco–Belgian coalfields is also know the Sambre–Meuse coal field.

Mons Coalfield

The second coalfield in Belgium is Mons field. The chief producing area is round charleroi with an extension northwards to La Louviere. Fig. 10·3 shows the coal fields of continental Europe.

The district round Liege, farther east is second in importance. The coal in the Mons area is mainly bituminous, used for household purposes and to produce gas; in the Charleroi mines are the chief supplies of coking coal, suitable for smelting; and round Liege is anthracite. The blast furnaces and steelworks of Liege depend largely on coke brought from Charleroi and from the newer campine coalfield.

The output from Mons with Borinage is about 3,987,C00 tons yearly; from La Louviere ten million tons, and Liege 4 million tons.

The Campine Coalfield

This is the third most important coal producing field in Belgium. Coal is mined on the newly developed Campine field near the Dutch frontier. It is a region of varied development. Along the line of the coalfield, industrial establishments are growing rapidly The largest town in the east of the Campine is Hasselt. At one time considerable quantities of Iron ore were mined on the Belgium coalfield

The Limburg Coalfield.

Limburg, Holland's South eastern province, extends far south

along the Maas or Meuse river. Here the landscape is quite different. Here are rock quarries, although stone is unknown in the rest of Holland except in the form of glacial boulders. Here also Holland has its share of the coal zone extending from northern France through Belgium into Germany. On the Limburg coalfield mining has greatly developed in recent years, and in this region there are now important chemical industries and factories where cement is made and glass and paper maunfactured. The production is sufficient to fulfill the national consumption, and canalization of part of the Meuse, together with a new canal connecting the Maas or Meuse with the Rhine system, makes it possible to ship the coal all over the nation.

Coal is found in three areas of France. The most important is the North-east or Nord coalfield, a western continuation of the Sambre Meuse field of Belgium. Among French coal fields the most productive by far is the North and Pas de Calais, and produces about 30 million tons of coal a year, that is, 52% France's total production. Much coal is sent to other parts of France by rail. Much is dispatched by canal, since France, like its neighbour Belgium, has a splendid system of inland waterways, and there are widely used for the haulage of heavy and bulky goods.

The Lorraine Basin

East of the Marne valley rises the plateau of Lorraine—a region with extensive forests, but poor soils, and with great wealth in its iron mines, which are among the most important in Europe. The Lorraine basin along the Saar frontier produces approximately 15 percent and is considered to be a large potential reserve from which future production may soon approach that of northern France. Some of the coal is used to generate electricity at power stations close to the mines, and some is fed to local iron and steel plants that draw their supplies of pig iron from Lorraine.

The Central Massif Coalfield

The third group of coalfields lies round the central Massif in a series of small isolated baisns. The chief of these fields is at St. Etienne, and the good coking quality has led to the development there of the iron and steel industry. The output from St. Etienne is 3,500,000 tons a year. The other important producing centres are Carmaux, Decazeville and Commentry in the western side of the Central Massif and Montceau-les Mines and Ales fields in North of St Etienne In all the coalfields of the central Massif produce 26% of France's output.

Coal is also found near Nancy. Broadly speaking that is the Southern continuation of the Lorraine coalfield.

Silesia Coalfield

To the west of Cracow is the Silesian coalfield of Poland, a densely peopled area of mines, dumpes of waste, blast furnaces, factories, and rows of grimy close packed houses. Coal in Poland is found in two basins :

(*a*) **The upper Silesia**—In the Little Poland Plateau coal has been found near the Sub Carpathian lowlands. Much coal is exported. Some is sent by rail to Danzig and Gdynia, and some by canal to the oder and thence to Szczecin.

(*b*) **Lower Silesian Basin**—Coal is also found in Lower Silesian basin in Walbrzych district in small quantity. The coal is of poor quality, friable, and does not seem to occur in any large quantity.

Western Coalfields of Poland

There are rich dopsits of brown or lignite coal in west Poland. The chief mines, which are open-cast, are around Konin and Turoszow. The dozen separated Polish coalfields taken together now produce only 15 million tons annually from western fields. Much lignite, however, is mined in western fields, where it is used primarily in thermal generating plants to produce eletricity, which supply current to a large part of central Poland.

Sweden's only coalfield is a small deposit in north-west Scania outside Halsingborg. The coal is poor and of no value for smelting; it is used for household purposes and to generate thermal electricity.

Coal is found in two areas in Iberian peninsula. The first of these is the south-eastern Iberian mountains coalfield. Coal is generally low quality, largely unsuitable for coke manufacture. Much lignite is mined in Ebro valley, where it is used primarily for chemicals.

Austurias coalfield

Between Gijion and Oviedo is the largest coalfield in Spain, producing bituminous and anthracite coal, though not of the best quality.

The Guadalquivir Basin coalfield

Near Belmez and Puertollano are two small coalfields of poor quality. Production, however, is not great.

After Germany and France, Yugoslavia ranks high among the countries of Europe in fuel resources. Hard coal is mined in the Timok and Ibar valleys in Serbia, but output amounts to only a million tons a year. Lignite and brown coal are more plentiful and widespread, the annual output being upwards of 23 million tons The chief producing areas are in the Bosna valley near Sarajevo, around Ljubljana in Slovenia, north-west of Belgrade, and in the Istrian peninsula.

THE SOVIET UNION AND ASIA

The total coal reserves of the U.S.S.R. are estimated as 1,200,000 million metric tons, or about 25% of the world's coal, as compared with 21·8% for the Communist China.

Russia has always been very rich in her fuel and mineral resources, especially in the Urals, Caucasus, Siberia and Altay. Russia is richer in coal than any other European country. Her

coal deposits are greater than those of Great Britain and Germany put together. The surveyed coal reserves have been estimated at 1,200,000 million metric tons. The main regions of coal deposits in the Soviet Union are :[1]

Region	Areas	Reserves of Good quality
In the European part and the Caucasus	1. Donetz Basin	59,613 million tons
	2. Moscow Region	11,578 ,, ,,
	3. Urals : West	341 ,, ,,
	4. Urals : East	469 ,, ,,
	5. Caucasus	281 ,, ,,
	6. Crimea	279 ,, ,,
	7. South west Region	47 ,, ,,
In the Asiatic part	1. Kuznetsk Basin	250,000 ,, ,,
	2. Kirghiz Steppe	4,783 ,, ,,
	3. Irkutsk Region	150,000 ,, ,,
	4. Yenisseysk Region	6,057 ,, ,,
	5. Sakhalin Island	1,660 ,, ,,
	6. Amur Region	376 ,, ,,
	7. Zabaykalye	201 ,, ,,
	8. Primorsky Kray	41 ,, ,,
	9. Yakutiya	1 ,, ,,
	10. Turkestan	314 ,, ,,

Coal is found in the Soviet Union in more than eighty areas, scattered from Moscow to Sakhalin and from the Arctic circle to the sea of Azov. There are mineral coals of various grades of different quality. One of the most essential differing properties of the coals is that some of them are coking coals which yield coke for the metallurgical production and others are non-coking coals, unfit for metallurgical production, used only for heating purposes and for the production of energy. The chief coalfields are :

Donetz Basin coalfield

The Donetz Basin is the most important coal basin in the Soviet Union. The Donetz basin, covering 26000 square km of Stalino and Voroshilovgrad regions, includes the basic part of the Ukranian industrial system. Donetz coal plays an outstanding part in the national economy of the country.

(*a*) it supplies power-generating fuel to the entire large-scale industry in the south of the European part of the Soviet Union, and to a considerable degree also in the centre and the Volga region,

(*b*) it satisfies the requirements of all the railways of the Ukraine and of the adjoining parts of the Russian Soviet Federative Socialist Republic and Byelorussia,

(*c*) it provides the entire metallurgy of the south with

1. From various sources : FAO Publications or the future supply of oil and gas or world Geog. of Petroléum or Soviet power : Energy Resources, Production and Potentials, 1961.

metallurgical fuel and the chemical plants of the Ukraine with raw materials.

In European part of the Soviet Union Donetz basin coalfield is the largest coal deposit, accounts for nearly 60%of total reserves. About 40% of the coal is anthracite but some is high-grade bituminous, suitable for coking.

The Kuznetsk or Kuzbas Coal Basin

This is the second in importance in the Soviet Union. It is situated in the basin of the river Tom, a right-side tributary of the Ob. This coal basin occupies about 26000 square kilometres, but considerably exceeds it in the size of Donetz basin and its coal reserves which compirse about three-tenths of the entire coal supplies of the Soviet Union. As regards the size the coal reserves, the Kuznestsk Basin ranks first in the Soviet Union and second in the world after the Appalachian coal field in the United States. The quality of its coals is higher than that of the Appalachian coals. Kuznetsk coal, which is consumed by the majority of power stations, constitutes the chief source of energy in western Siberia. Not only the local power stations and plants, but also the giants of the Urals heavy industry, have become its important consumers. Coal from Kuznetsk basin and the nearby deposits of iron ore and limestone are the basis of Magnitogorsk's steel industry.

The Karaganda Coal Basin

. The Karaganda coal basin lying in the centre of kazakhstan and abounding in coking coals is the third largest coal base in the Soviet Union after the Donetz and the Kuznetsk basins. The coals of the Karaganda Basin, which is twice as close to the Urals

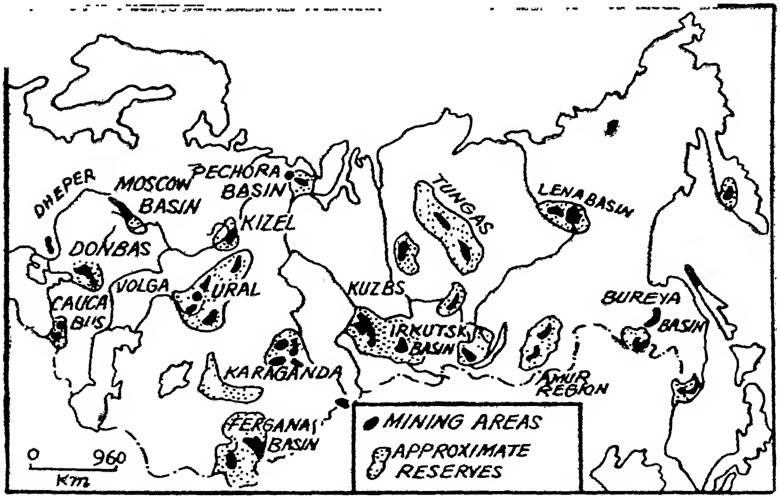


Fig 10·4. Coal fields of the U.S.S.R.

as the Kuznetsk Basin, are coking coals. The large Karaganda Basin with its coking coals and the availability of coals of local importance make it possible to process the rich and diverse mineral resources of Kazakhstan at the place of their extraction.

There are also coals of local importance in Kazakhstan; they are deposited near the borders of the republic in the west, south and east (Ekibastuz in the north east, Lenger to the South of Chimkent etc.)

The Karaganda coal basin is the principal fuel base of the mining and metallurgical industry of Kazakhstan. The bulk of Karaganda coal, however, is shipped to the South Urals. Fig. 10·4 shows the important coal fields of the U.S.S.R.

Moscow and Tula Coalfield

In the European part of the Soviet Union are the central. or Moscow field, whose chief centre is Borodino and the reserves of which amount to 12 million tons. Coal is also extracted in the Tula province. Tula is the organizational centre of the steadily growing Moscow coal basin. These two areas, though essentially producers of lignite, are nonetheless important because of their proximity to major markets.

Urals Coalfield

The Urals coal reserves are concentrated in the coal fields of Kizel (north east of Molotov), Yegorshinsk (east of Sverdlovsk), Chelyabinsk, Bogoslovsk, and a number of localities in Bashkiria. But the Kizel deposit is the only one which yields coking coal. The rapid growth of industry, transport and towns in the Urals has called forth a respective growth of the demand for energy. The output of coal has increased many times, especially that of the Kizel and Chelyabinsk coal-fields. Deposits of brown coal are exploited in the vicinity of Chelyabinsk. Chelyabinsk is the second largest industrial centre of the Urals after Sverdlovsk, its growth being rapid and incessant. The coals of all other deposits are fit only for heating purposes, and cannot be used by metallurgy. The Kizel field in the central Ural region, all the fields in the Urals together having a reserve of 6500 million tons.

Caucasus Coalfield

The eastern wing of the Donetz basin which projects into the territory of the Kamensk Region, supplies coal to the whole of the Northern Caucasus up to Daghestan. In the recent years coal deposits have been found in the South of the Voronezh region and shale deposits in the South-east, but these deposits are still insufficiently prospected. The important centres are Rostov, Taganrog and Novoclerkassk. In Caucasia there are fields at Kutaisi in Georgia and Tanabcheni in Abkhasia, and even larger ones on the northern slopes, the region having reserves of nearly 4000 million tons.

Irkutsk Coalfield

Coal is extracted mainly in the Cheremkhovo district, near Irkutsk and in Chita. Its coal resources (including brown coal) are almost twice the size of those in the Kuznetsk basin. The largest of the coal basins are located far in the north, near the Polar circle; but there are basins with considerable coal reserves also in the Southern zone, along the railway main line, namely, the Chulym-Yenisei, Minusinsk, Irkutsk Cheremkhovo and Kansk basins. Of particular importance is the Irkutsk-Cheremkhovo basin which takes a leading place for the size of its already prospected coal resources and which yields the cheapest coal in the Soviet Union. Chita is the centre of the region; it is located east of the Yablonovy mountain range. There are coal mines nearby.

Kirghiz Coalfield

In central Asia coalfields exist at Shural in Tadzhikistan and in Kirghizia, with reserves of nearly 4000 million tons.

Yenisseysk Coalfield

The Yenisseysk coalfield consists of the area of the Yenissey Basin, which divides western Siberia from eastern Siberia and forms the present administrative Unit of Krasnoyarsk Kray. The main occupations in the Krasnoyarsk kray are forestry and the extraction of coal and minerals. Coal deposits occupy a large area all along the Lower Tunguska and at the mouth of the Yenissey. In Asia there is a series of coalfields in central Siberia at Kyzyl and in Transbaykalia, the coal fields at Minusinsk and Kansk and at Shulim near Krasnoyarsk which has a reserve of 40,000 millions tons.

The Far East Coalfields

The Far East of U.S.S.R. is particularly rich in resources. There are deposits of coal and brown coal. Coal is found in Sakhalin, near Suchan Artem, Yuzhno, Poronaisk and Bureya basin. The deposits in Sakhalin, according to the estimates of Prof. Ramzin, are over 2,000 million tons.

In Far East the important mining centres in Amur basin are Blagoveshchensk, Birobijan Selemdzha and Zeya valleys.

Turkestan Coalfields

Turkestan is a land of mountains and Oases, a land where cattle-breeding and agriculture have always been, and still are, the main occupations of the major population. The mineral fuels of Turkestan have been explored only in recent years. The chief source or energy is coal. Coal is mostly found in the upper valleys of Zeravshan and Naryn rivers and south east of Tashkent. Chief among them are : coal deposits in Uzbek Socialistic Soviet Republic and North of Stalinabad which provide inexhaustible supplies of raw materials for the chemical industry.

There are deposits of brown coal at Borovichi in Leningrad region. The coal deposits of the Pechora basin are of importance beyond the bounds of the North-East of the European part of the

Russian Soviet Federative Socialist Republic. The Pechora coals are supplied to Leningrad with which the coal fields are now linked up. There are deposits of coal near Selizharov which are exploited and serve the requirements of Leningrad—Kirov region.

CHINA

China is extraordinary in the amount of coal and other minerals it possesses According to National Geological Survey, China occupies the fourth place after U.S.A., U.S.S R. and Canada. China's reserves fortunately include large amounts of anthracite—one sixth of the total. Seventy percent of China's reserve lie in the provinces of Shansi and Shensi in the region of loess hills. This area is relatively inaccessible, so that the principal mining developments have been near the sea coast and the main railways. China's coal, which is found in about 200 large fields, is located principally in the north-western and north eastern parts of the country—in the Loess Highlands of Shansi, Shensi, Honan, and Kansu and in Manchuria, Anhwei Province, Shantung, and Hopei. The provinices of Hopei, Honan, Shantung and Shansi have about fifty mines and account for some 20 million tons annually. Their reserves repre sent half of all China.

The chief coal fields are :

North Eastern Coalfields

The most important mine is that at Fushun east of Mukden or Sanyang. Here there is a bed of tertiary coal, exposed at the and dipping same thirty degrees with a thickness of 12 to 131 metres. This is the thickest beds in the world of bituminous type volatile coal. Other important centres are Penchi, Hsian, Heilungkiang, Haokang and Kirin. Liaoning takes first place with a capacity of 15 million tons a year. Much the largest concerns are the Fushun in the north-east and the Kailan in Hopei, whose fields, though small have each an important strategic position, being in close contact with the railway focuses of South Manchuria and of north China, respectively. Chinwangtao, a port close to the Kailan mines, developed a larger coal shipping trade than any other port east of Suez.

Fushsin Coalfields in North-east

Fushin mine in Jehol is 180 kilometres west of Mukden or Sanyang. The Fushin coal seams are 60 to 100 metres thick. The annual production has reached over five to seven million tons, and many even surpass the output of Fushun field.

The Northern Coalfields

Coal and Iron are found in the Southern part of the province of Shansi and the northern part of Honan. The coalfields in Shansi are of vast extent. The Shansi mine has good coking coal. The coal occurs, too, near the surface, so that mining is easy ; but the difficulty of transporting the coal to the districts where it is most required has prevented a great development of mining up to the present. The

coals are of high quality, including coking coal and large amounts of anthracite.

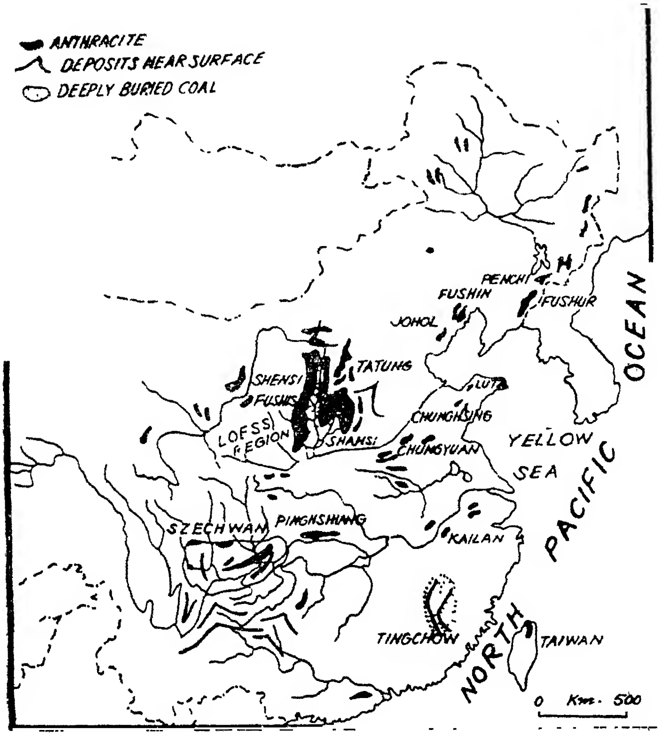


Fig. 10 5. Coal fields of China.

Middle China fields

Mining is most active in Talung along the lower Yangtze valley and in Red basin and these two regions are also the chief centres of coal industry. Other important coal producing centres are Chinghsing and Mentoukou in Hopei. The output from Red basin with Talung is about 2 million tons ; from Mentoukou 1 million ; and Chinghsing two million. Towards the west, especially in Red basin the coal of Carboniferous age holds larger reserves of coal and while the middle coalfield is still the most .productive area, the western Interior fields are increasing in importance. The Middle area has the high-grade anthracite smokeless and many grades of steam coal. Low volatile coking coals and lignite coals are from the crescent area east of the Cheng–Tu round the ends of the Yunling and Kinghsa valley.

Shan-Tung Coalfields

Most of the coal in the Shan-Tung peninsula is found Luta

and Chunghsing, both of Carboniferous age, the former being the more important one.

Southern China

The only important mine in South China is that of Pingsiang among the hills of the Hunan-Kiangsi border, and this too is linked with the railway system. Coal also occurs in Yunnan. The province of Yunnan is rich in copper and tin, besides coal. The bulk of the Southern Chinese coal is lignite, of low and medium rank , good for steam-raising, domestic and industrial purposes.

JAPAN

The former director of the Imperial Geological Survey, K. Inouye, in 1911 estimated the reserves of coal in Japan proper at 6·22 billion tons, of which less than a billion tons represented "actual" reserves and the balance 5·27 billion tons, "probable" reserve. On the basis of a survey conducted by the mining Bureau of the Japanese Department of Commerce and Industry in 1932, somewhat higher figure for coal reserves have been published.

Coal is mined in several parts of Islands. The most important coalfields are :

Kyushu Coalfields

Although Kyushu lie in the South-West-South Corner of Japan, it has an important mining history. About two- thirds of Japanese coal is mined in northern Kyushu, and the remainder in Honshu and Hokkaido. In nothern and western Kyushu there are number of separate coalfields. The quality of coal is mostly of Tertiary age. Over more than half-dozen separated Kyushuan coalfields taken together now produce 30,000 million tons. The most important of these, the Chikudo field, with 20,000 million tons capacity, covering over 182 km^2. Some what farther to the west and South west are several less important coalfields such as Miike, Karatsu, Sasebo, Sakito, Matsushima, Takashire, Amakusa and Yaeyama.

The larger part of Kyushu's coal goes by lighter, barge sailer and small steamer to districts south and west of the Tokyo region, and several million tons are consumed as banker fuel.

Honshu Coalfields

The important coalfields in Honshu are the Joban coalfields with an area of 14 sq. km. the Nobi coalfields with an area of 11 sq. km., the Ube coalfields with an area of over 4 sq. km. and Nanokaichi coalfield has an areas of 10 sq. km. with two workable seams, 1 metre and 2 metres thick. The Tertiary coalfields of Honshu occur in Aburato, Mogami, Sendi and Suzuka. Though the coal from Honshu is of inferior quality, being rich in ash and sulphur, it has the advantage of proximity to the great Kwanto industrial node just to the south, with which it has excellent rail connections. Joban coal is the most important single source of

energy supply for the Kwanto industrial node. Ube coalfield on the shores of the inland sea in the extreme south-western part of Honshu is the main source of energy for Yamagüchi prefecture. The coal is inferior quality, but location on the shores of the Inland sea tidewater permits cheap transportation by small boat to the industries centres-especially Osaka and Kobe. Coal is brought by boat chiefly from Ube and Northern Kyushu fields. Lignite is mined in the Nobi Bay reigon to the east of Nagoya industrial centre. Good industrial coal is not available locally, although the adjacent lignite beds are utilized by the ceramics industry and some others. Lignite is also mined at Takasaki in the Kwanto district and at Mogami and Sendai in northern Honshu. Fig. 9·6 shows the distribution of coal in Japan.

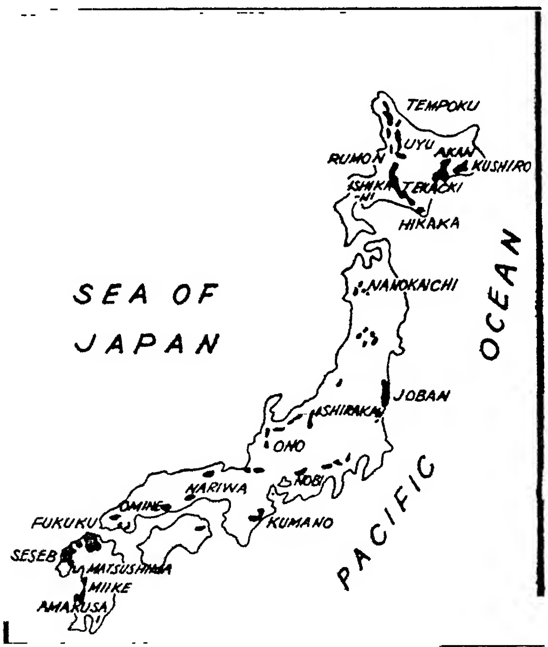


Fig. 10 6. Coal fields of Japan.

Hokkaido Coalfields

The most extensive 'actual' or 'probable' coal deposits of Japan are located in the northern most Island of Hokkaido or Yezo. Small coalfields widely scattered throughout the northern Island of Hokkaido. Most of the mines have been opened more recently and hence equipment and mining methods are more upto date. Chief among the Hokkaido coalfields is Ishikari, located in the Tertiary rock hill lands just east of the Ishikari plain in west-central Hokkaido. The island contains the largest coal-reserves, but they

are unfortunately much disturbed by faulting and folding. The Ishikari coalfields have several seams of various thickness and the estimated reserves are the largest of all the individual Japan coalfields. Coalfields of Ookkaido include Tempoku coalfield, Hapora coalfield, opiraushpetsu field, Rumoi field, Orapora, Kayanuma and Uryu fields. The other Hokkaido coal fields are worked on a smaller scale. Among these are the Kushio, Akan and Shiranuka fields in the east, back of the port of Kushiro. The eastern coalfields of Hokkaido have several fairly thick seams but the coal has high ash content. The Kushiro coalfield has an area of -u sq. km. with two workable seams of 2 metres each.

AUSTRIAN COAL RESOURCES

Australia contains only about 1·3 percent of the world's coal resources. The important coalfields are :—

The Newcastle coalfields

This basin occupies an area of about 25,900 sq. kilometres. It extends along the coast of the north and south of Sydney, which is in the centre of the coal basin. The Newcastle seams is over 500 metres thick. There are dozen coal mines especially at Bulli, coal cliff, Mount kemba etc.

The Victoria coalfields

Coal seams almost 400 metres thick have been discovered in Latrobe valley of Victoria. Yallourn is important coal mining centre. Coal is mostly of brown quality.

Queensland coalfields

In Queensland the important coal producing areas are Mount Mulligan. Collinsville, Downson and Mackenzie valley. Of all these the Mackenzie and Ipswich probably contain the biggest reserves as shown in table 10·1.

Tabl 10·1

Coal Reserves of Australia

Centres	State	Reserves in million tons
Morwell	Victoria	5,000
Trarlagon	,,	5,600
Ontrim	,,	30
Newcastle	N.S.W	14,000
Lithgow	,,	
Bulli	,,	
Collie	W.A.	3,500
Mackenzie	Queensland	112
Mt. Mulligan	,,	15
Clirmont	,,	208

At present the Ipswich field is the largest producer. The other important centres are Four fort, Bluff-Aberdare, the Seventy foot etc.

South Australian coalfields

Coal is found about 160 kilometres to the South of Lake Eyre. There are three coal bearing basins in this region, but the workings are mainly confined to the central larger basin.

Western Australian coalfields

By far the most important field in the State is near Collie, 200 kilometres south of Perth. The coal measures are about 800 metres thick and contains 14% of aluminium phosphate, so that it may have some value as a fertilizer.

AFRICAN COAL RESOURCES

The formation from which nearly 75 percent of the coal supplies in Africa is obtained from Karoo system. The beds of this series are of small thickness, but they are known, and, from thier peculiar features, easily recognised in most of the coalfields. They include boulder-beds supposed to be due to glacial action, and are thus regarded as similar in origin, probably also corresponding in geological age, to the Gondwana formation which lies at the base of the similar coal-bearing Damuda system in peninsular India. Thus, the African coal-measures are not much younger than, and may even be of the some age as, those of Europe. It is chiefly composed of sandstones and Shales, which, except for some exposures along the South African coast, appear to have been entirely deposited in fresh water, and probably by rivers. Such sediments occur in the Cape province of South Africa as well as widely in the Sahara and the western Sudan. Continuing the geological sequence, the Carboniferous system contains very extensive land deposits. especially notable of which are those of the lower Karroo beds in the Union of South Africa : these are upper Carboniferous in age and, like the corresponding series of Europe, include very valuable coal-seams. Outside the union similar coal-bearing beds occur in Tanganyika Territory, Nyasaland and Southern Rhodesia.

Union of South Africa

The Union of South Africa is well endowed with bituminous coal, and about 30 million metric tons are mined each year in the provinces of Natal, Transvaal and Cape of Good Hope. The chief coal fields are :

Coal-fields of the High Veld

About 40 percent of the annual output of the Union of South Africa, which exceeds 20 million tons, is obtained from the Witbank field of High Veld in the province of the Transvaal. The Witbank coalfield is located, 128 kilometres to the east-North east of Johannesburg. The product is good steam coal but is not suitable for coking purposes. The seams with an average thickness of 20

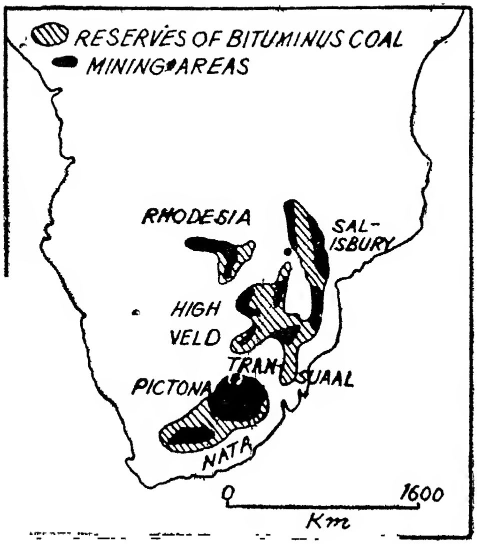


Fig 10 7. Coalfields of South Africa.

metres have played an important part in the industrial establishment of the Union of South Africa. Other fields of the Southern Transvaal that together make a valuable contribution to the total output of the province are those of Ermelo, Carolina, Heidelberg and Vereeniging. Coal is also obtainable from Middelburg field.

Natal Coalfields

Four coal-bearing tracts occur within the northern half of Natal. The Vryheid field produces more than half of Natal's output. In the extreme north-west and close to the main railway, where it traverses the Natal terraces between Newcastle and Ladysmith, is the most extensive coalfield, covering more than 2600 sq. km and producing the high-grade steam coal that is transported to Durban for the bunkering of ships. Fig. 10·7 shows the coal field of South Africa.

A little coal is found in the province of the Cape of Good Hope, the chief mines being at Indwe.

Rhodesian Coalfields

The country is rich in minerals. Actually, the only coal mine that produces is at Wankie, on the railway between Bulawayo and Livingstone, but its present output, little more than a million tons annually, could be increased in the event of an expansion of industry.

INDO-PAK SUB CONTINENTAL COAL RESOURCES

The coal deposits of sub-continent belong mainly to different periods, the earlier being the lower Gondwana era, perhaps about 350 million years ago, and the later being the lower or middle Tertiary era barely 30 to 60 million years ago.

The Gondwana Coalfields

The Gondwana coals have been preserved on the eastern part of the Peninsula bv being faulted down into the Archaean basement complex; but either the faulting or the softness of the Gondwana rocks has determined the direction of the Damuda, Mahanadi and Godavari valleys in which the principal fields are found. In Madhya Pradesh the Gondwana rocks from the Mahadeva or Mahadeo Hills, a portion of the Satpura hill-range, which stands up above the general peneplain of the Peninsula.

The fields which have been worked to an appreciable extent inclue Raniganj and Jharia in the Damuda or Damodar valley. The Giridih field occurring as a small isolated patch to the north of the Damodar valley; the Daltonganj field, further west, in the Palamau district the Singareni, Ballarpur and Warora fields in the Godavari valley, the Mohpani and Pench valley fields lying respectively at the northern and southern fringes of the Satpura Range. Before the great depressions now occupied by the Indus, Ganges and Brahmaputra were formed, the Gondwanas probably stretched in great sheets of sandstones, shales and coals as far north as the area now occupied by the other Himalaya, and fragments of the strata caught up in the Himalayan folds are now preserved near Darjeeling, in Bhutan and in NEFA. The coal in these extra-Peninsular patches of Gondwana rocks has been damaged by crushing, but prospecting operations[1] in the Darjeeling district have shown that there is valuable fuel obtainable in this area.

The north-western ends of the Godavari and Mahanadi belts of coalfields have been overwhelmed by the great sheets of Deccan trap, and no one knows, consequently, how much coal lies hidden under this mantle in Madhya Pradesh and Orissa and Andhra Pradesh. Similarly, the eastern ends of the Jharia and Raniganj fields are buried under the Ganges alluvium making it impossible to determine the quantity of coal in India.

Most of the Gondwana coals belong to the class called bituminous, covering a fairly large range of composition and used for various purpose—for steam raising, for gas production and for general heating purposes. The coking quality of coal is of great importance for industrial purposes, particularly for iron and steel making where good coke is needed for metallurgical operations. There are as many as 80 individual coalfields in the Gondwana formations in India The best known coalfields are those of Raniganj in Bengal; Jharia, Bokaro, Karanpura and Giridih in Bihar; the Pench valley and Kanhan valley, the Umaria, Sohagpur and other fields in Madhya Pradesh may be put on the border line or under semi coking coals and may be useful for blending with strongly coking coals for the production of a reasonably good metallurgical coke.

Practically 97 percent of the coal supplies of India are derived

1. P.N. Bose, Rec. Geol. Sur. Ind., vol. XXIV, p. 212. 1891.

from the Gondwana rocks which are found in the Deccan tableland. These rocks are very old and are composed chiefly of sandstones and shales. The only section of the Gondwana system which is important from the point of view of coal production is that known as the Damuda series from its development in the valley of the river Damodar. In the Raniganj and Jharia fields these rocks can be sub-divided into three stages or divisions, of which the top and bottom divisions, known respectively as 'Raniganj' and 'Barakar' stages alone contain coal seams. The rocks lying, between these two divisions are 'Ironstone Shales'. The most important coal seams in the Raniganj coal-fields are found in the Raniganj stage while the most important seams in Jharia coal-fields occur in 'Barakar stage'; that is, good coal occurs in upper rocks in Raniganj coal fields and in lower rocks in Jharia. The most important coalfields in Peninsular India are :

The Jharia Coalfield

The area of Jharia coal-field is only 387 km². The Barakar series or the lower layer of the Gondwana rocks, are by far the most important coal bearing seams of the field. There are about 18 seams over 61 metres thick. This is the most important Indian coal field not only because it produces about one-half of the total coal produced in India, but because it produces the best variety of coal in India. By far the larger proportion of hard coke made in India is made from Jharia coal, and the recovery of coke averages about 75% of the coal used It lies on the margin of the Ganga Plain with the network of railways, and coal is transported to the industrial landscape of west Bengal and Bihar.

The Raniganj Coalfield

It covers an area of about 1290 sq. kms. most of it being in the district of Burdwan, but stretching also across the boundaries into Birbhum, Bankura, Manbhum and the Santhal Parganas. It occupies a larger area than the Jharia coal field. The seams dip generally to the south and south-east throughout the field. As dippings to the south east are covered by the alluvium of the Damodar, the distance to which through the coal bearing rocks extend in this direction towards Burdwan and unkown in Calcutta. There are six workable seams in the upper Raniganj rocks totalling roughly 16 metres of coal. The Dishergarh seems of Raniganj has the most valuable steam coal in India which is in great demand for railways and ships. The Raniganj mines are deepest in India and seams occur up to a depth of more than 610 metres.

Jharia Bokaro Coalfield

This field is situated west of Jharia field on the other side of the Jammu river. The coal in the Jharia-Bokaro area is mainly bituminous, used for multi purposes and to produce gas. The blast furnaces and steelworks of Bokaro depend largely on coke brought from Jharia-Bokaro field and from Jharia coalfield.

Ramgarh Coalfield

The small field known as the Ramgarh coalfield lies from 24 to

32 kilometres south west of Bokaro. It is traversed by the Damodar river in the bed of which the coal is found in numerous places.

Ballarpur Coalfield

The seams of Ballarpur are 16 metres thick. Two portions of it are workable.

Mohpani Coalfield

The Mohpani coalfield is situated in the Narsinghpur district on the South of the Narmada alluvial valley, and at the foot of the northern spurs of the Satpuras.

Singareni Coalfield

The great belt of Gondwana rocks, near the north-west end of which Warora is situated, stretches down the Godavari valley as far as Rajamundry, and at one or two places the equivalents of the coal bearing Damuda series in Bengal are found cropping up from below the upper Gondwana rocks. One of these occurrences near Yellandu in the Andhra Pradesh forms the coalfield well known by the name of Singareni. The principal seam of coal is about 2 metres thick which is a dull hard and non coking. steam coal largely consumed by railways and mills in Southern India.

Raigarh, Mand river valley, Korba Himgir and Pench valley constitute a coalfield that is fifth in importance only to that at the head waters of the Mahanadi The bituminous coal is not as good in quality as that of the Damodar valley fields, but it is better than most of the coal of Wardha valley, and its nearness to Balaghat, and the manufacturing centres of Bhilai and Raipur makes it the chief supplier of this region. Fig 10·8 shows the coal fields of Peninsular India.

The Satpura coal has long provided power for the Cotton Textile Mills of Bombay and nearby towns. The varied coals of Sonada and Shapur support huge Cotton and Textile, gas, cement, chemical, potash, drugs, sugar, Hydrogenated vegetable oil and Royan industries in Bombay, Surat, Poona, Ahmednagar etc. Pench coalfield support a similar industrial development around Nagpur.

Tertiary Coalfields

The newer or Tertiary coals of Assam differ from the Gondwana coals in containing large portion of moisture and volatile matter. They also generally have lower ash content. The Tertiary coal have a high sulphur content which makes them useless for coking.

The most important among the Tertiary coal are the Assam coals near Makum. Tertiary coalfields are found in upper Assam, as well as in the Garo, Khasi and Jaintia Hills on the Assam plateau The most valuable seams occur between the Tirap and the Namdang streams where, for a distance of about eight kilometres, the seams vary from 5 to 25 metres in thickness. Coal occurs in various parts of Assam and has long been known to occur als

in Mikir Hills. The chief outcrops are at Langloi, Disoma, Nambor and Doigroung.

Coal is also found in the lower slopes of Kalais mountain in Garo Hills of Assam. The chief outcrops are at Walzong, Dhongring and Wamong. Further South east a coal bearing belt of Tertiary rocks has been found to extend throughout the length of the Khasi and Jaintia hills at least from the Garo Hill southwards. A coal-bearing region, extending over on area of 36 km² has been located in Bankura district of west Bengal.

Some coal is found in the Tertiary beds of Kashmir. Coal has long been known to occur also in south western parts, but the prospects of successful exploitation are doubtful. The chief outcrops are at Kalkote, Matka, Mohogala, Chakar and Dadli in Chinab valley, Landa, in the east of Chinab river are Ghansala and Sabalkote etc. The coal is of anthracite type, containing very high quantity of fixed carbon.

Seams of lignite occur in Bikaner and Jaisalmer in Rajasthan. Mining operations on the lignite of Palana in Bikaner were begun in 1898 of a point where the seam was found to be 6 metres thick. At Shib, 64 km. in a direct line to the north-west of 'Jodhpur, there is a deposit of lignite similar apparently to others found in Rajasthan.

New coal deposits have also been discoverd in the Daup area of Nepal Tarai (the western districts of Khajawali and Sohratgarh). Coal is said to be of high grade. Digging operations have been started with the help of the U.P. Government.

New coalfields have been discovered in Rewa (Pathakera and Korba) and Hutar in Bihar. The Garo Hill in Meghalaya, Jammu and Kalakot in J. and K. have been surveyed to contain large deposits of high grade coal. Large lignite deposits have been discovered in south. Arcot district at Nayveli, covering an area of 42 km² with 10 metres in thickness. The development programme for these deposits envisages the mining of 35 lakh tons per year of lignite which is to be used for (*a*) generation of power (2·5 lakh kw) (*b*) production of carbonised briquettes (3 8 lakh tons) and (*c*) production of fixed nitrogen (70,000 tons). The production of coal in India since 1970–71 has been as follows.

Table 10·2

Production of Coal and Lignite

Production (in 000 tons)

Year	Coal	Lignite
1970–71	6142	295
1971–72	5958	305
1972–73	6231	256
1973–74	6463	352

The production of lignite, however, fell from 305,000 tonnes in 1971–72 to 256,000 in 1972–73, the same is the case with coal production during 1970–71 and 1971–72 as shown in table 9·2. Practically the whole of this 97 to 98 percent comes from the Gondwana coal fields and 2 to 3 percent from Tertiary coal fields of India.

Production of Coal

The Great Britain has a long history as a coal producer. Most of the coal mines are in the east and west side of Pennine chain. At present times the United States of America attains second place in world output and is regularly the largest producer in western hemisphere. After great Britain and the United States, Federal Republic of Germany ranks third among world producers of coal, followed by Australia, U.S S.R., Japan, Yugoslavia, Philippines, German Democratic Republic etc.

In Union of Soviet Socialist Republics, there are vast resources of coal, mainly in Siberia, though the Donetz Basin (Donbas) was the most intensively worked before the war. The Danbas supplies coal for the metallurgical industry of the south as well as raw materials and fuel for the chemical industries and transport of the Ukraine. In spite of the tremendous devastation wrought in the Donbas during the world war II, this area has now been completely rehabilitated, and is once more the highly mechanized and productive coalfield of the country. The coalfield near Moscow, too, has been rapidly restored. The Kuznetsk Basin is the second in production in the U.S.S.R. The U S.S.R. has the world's largest coal output. Production in 1972–73 reached 655,000,000 tons. Coal Production of important countries are shown in table 10 3.

Table 10·3

Coal Production of the World[1]

Figures in tons

Country	Production
Albania	5,900,000
Australia	759,600,000
Austria	3,770,000
Belgium	10,990,000
Bulgaria	29,182,000
Canada	19,336,000
Czechoslovia	11,300,000
Federal Republic of Germany	2,128,850,000
Hungary	25,800,000
Italy	1,510,000
Japan	396,940,000
Korean Democratic People Republic (N.K.)	27,000,000

1 Data from various Sources N. A.=Not available.

Luxembourg	N.A.
Mongolian Peoples Republic	19,970,000
Morocco	1,890,000
Netherlands	28,120,000
Peru	92,000
Poland	179,000,000
Portugal	253,263,000
Romania	165,570,000
Repubulic of S. Africa	586,660,000
Spain	8,140,000
Turkey	695,000
Great Britain	1,170,000,000,000
U.S.S.R.	695,000,000
U.S.A.	39,014,560,000
Venezuela	31,000,000
Yugoslavia	309,410,000
Philippines	188,520,000

CHAPTER 11

PETROLEUM RESOURCES

Power, heat, light and lubrication, etc, are the chief uses of Petroleum today. While many products are derived from petroleum at present, none renders a greater service to mankind than the oils and greases that are used to lubricate the countless moving parts of modern machinery.

Petroleum's Role in Improving Economic Life

Petroleum exercises a deep influence on modern industrial civilization. Petroleum fuels power the engines of automobiles, buses, farm tractors and trucks as well as those of fishing craft, merchant ships, passenger liners and aeroplanes.

The major developments in the industry during recent years have been the establishment of production facilities for a wide range of by-products like gasoline, gas, asphalt, coke, paraffin, wax, canning wax, etc. The steady increase in this demand has greatly increased the value of these oils, to, great improvements in refinery practice in order to obtain the highest possible quality of petrol from both heavy and crude oils. As these uses have been admirably summarized by an American petrologist in the article on "Petroleum in the world Atlas of Commercial Geology," published by the United States Geological Survey, the following quotation is submitted—

"Petroleum is used chiefly as a source of power, light and lubricants, and these are the uses that everyone knowns. Crude petroleum is used in decreasing quantities from year to year, more and more of it is prepared for higher utilization by breaking it up into refined products of greater value. The number of these refined products is almost countless, and their used are as varied as the needs of mankind. The light gravity ethereal products are employed as local anaesthetics. The gasolines are the universal fuels of internal combustion engines. The naphthas are extensively used as solvents and are blended with raw casing head gasoline to make commercial gasoline. The Kerosenes, though used chiefly for illuminations, are employed in increasing quantities as fuel for tractors. The lubricating oils and greases are indispensable to the operation of all kinds of machinery. The waxes derived from petroleum of paraffin base are utilized in many forms—as preservatives, as sources of illumination, and as constituents of surgical dressings made for the treatment of burns. Petroleum coke, an almost pure carbon, is used in metallurgy and in making battery carbons and light pencils. Fuel oils obtained as by-products in refining petroleum are used for generating power by industrial plants, railroads,

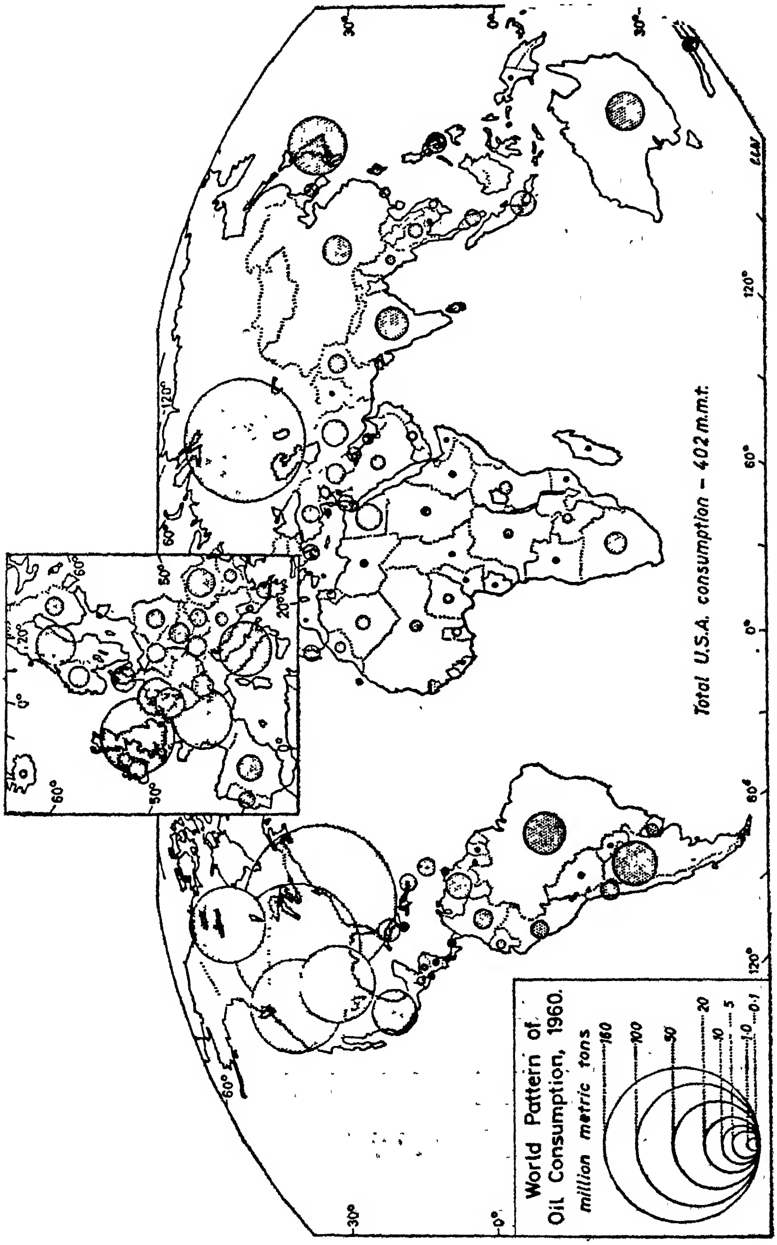


Fig. 11·1. Oil Consumption

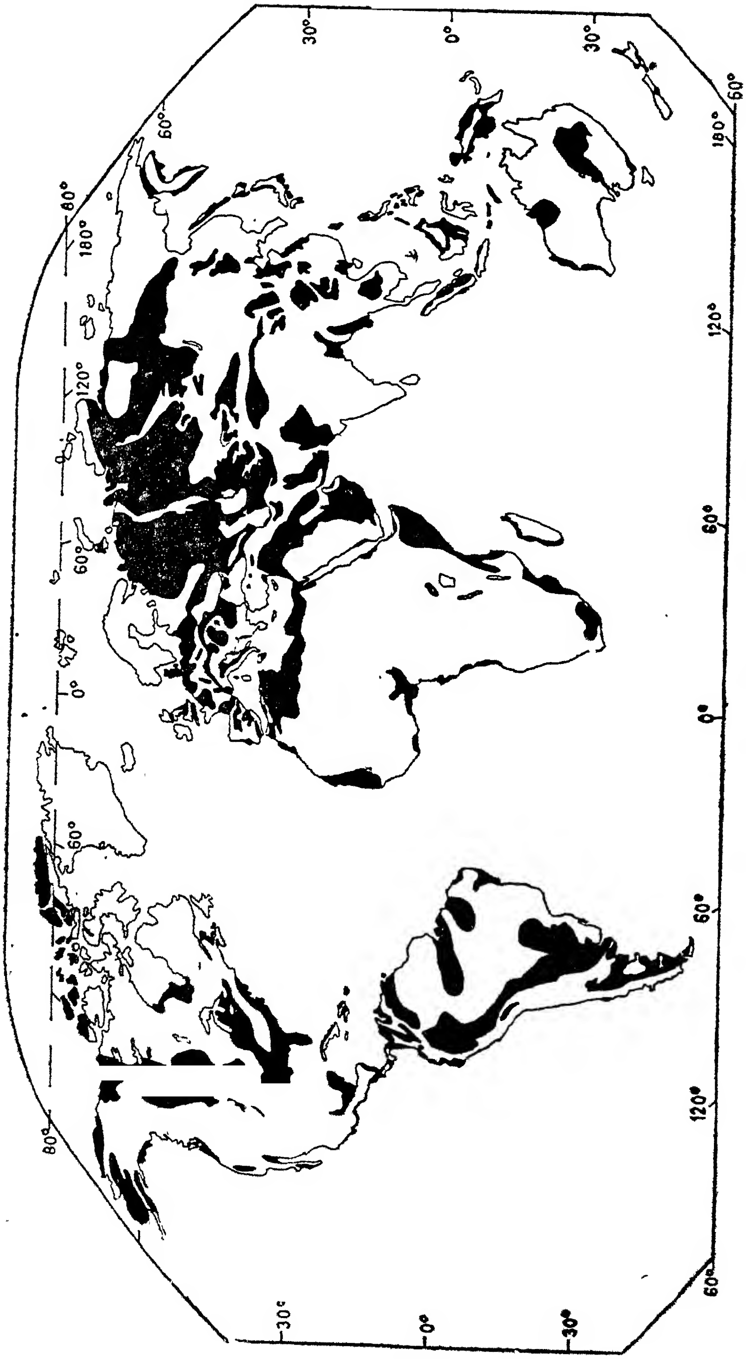


Fig. 11·2. Sedimentary areas of the World

and ocean steamers. Road oils are employed to lay the dust on streets and highways, and artificial asphalt, a porduct of petorleum, has in some places been used for paving." Oil is the basis of modern civilization. More than 5000 different by products have been developed from crude oil.

Occurrence of Petroleum Resources

The workable deposits of petroleum are confined entirely to Sedimentary rocks which have suitable structure. Most of the peninsular India consists of granites, metamorphic rocks or ancient sediments which do not contain petroleum. We should, therefore, look for petroleum only in the regions around the borders of India, where extensive sedimentary formations occur. Amongst sedimentary rock particular attention is paid nowadays to those of the Tertiary age, because the majority of petroleum occurrences in the world are in Tertiary sediments, which is shown in Fig 10·2.

The Oil fields of North America

The recognized birth of the U. S. petroleum industry occurred in the backwoods of western Pennsylvania, near Titusville. Before 1859 wells were dug by hand or petroleum was recovered from seepages.

By the latter 1950's the U. S. petroleum industry was one of the largest and most important parts of the country's economy. The U. S. also was the largest oil-consuming nation of the world. This peacetime consumption represented an estimated 50% of total world consumption. Moreover, the U. S. had provided the bulk of the oil used by the Allied military establishments. Although there were recurring oil shortage, but the restriction's on the consumption of petroleum products may become inevitable in view of the uncertainty about crude oil supplies from west Asian countries and rapidly increasing prices. The fuel problem of U. S. will be nothing compared to what confronts western Europe and Japan. Less than 10 percent of the 15 million barrels of oil that the U. S. consumes daily comes from Arab sources. In another three years or so, with the completion of 1280 kilometres pipeline, the oil from the northern slopes of Alaska should begin flowing steadily to make up for the loss of Arab supplies. For longer term need, the U. S can exploit its coal and oil shale deposits which, according to an MIT study, "are larger than the world's total oil reserves" and from which petroleum may be produced in "a socially acceptable way" by early 1980's at a price lower than that of crude from west Asia. There are eight distinct petroleum-producing regions in United States.

Appalachian oil field

The oldest, known as the Appalachian oil field in U.S.A., runs from southwestern New York through western Pennsylvania, eastern Ohio, west Virginia, Kentucky and Tennessee. The Appalachian field still occupies a comparatively low place among the oil producing fields of the United Sates, and in 1960 turned out only

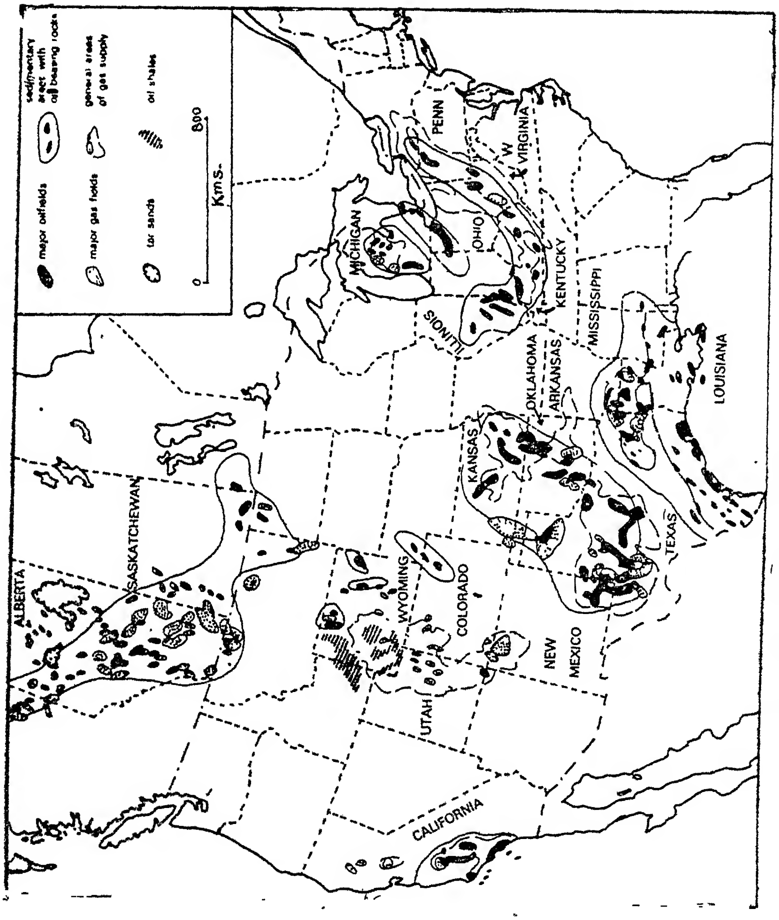


Fig. 11·3. Oil fields and Natural gas areas of U.S.A.

1 percent of the nation's total supply. Since their refineries—the first in the United States–went into production at Pittsburgh (with 48 thousand barrels daily), Cleveland (207 thousand barrels), Erie (75 thousand barrels), and New York (with 813 thousand barrels daily) about one hundred ago, a steady supply of over a hundred different kinds of petroleum products has been maintained. Fig. 11·3 shows the important oil fields of U.S.A.

The Lima and Indiana field

This oil field began production in 1876. In 1901to 1910 the production rose to 17 million of barrels but the average during the past five years is under 0·1 million of barrels.

Michigan oil field

In the year 1920 Michigan began to produce for the first time. Production in 1953 amounted to 12 million barrels, as compared with a peak of 23 millions in 1939. At the close of 1953, there were only two refineries in Michigan, which had an annual capacity of about 160 thousand barrels daily. The greatest centre is in Lansing, its capacity has now been increased. The second important centre is at Detroit. The Refineries produce Motor-spirit, Kerosene, aviation turbine fuel, high speed diesel oil, light diesel oil, bitumen, liquified petroleum gas and special boiling point solvents.

Illinois-southwestern Indian field

Oil was discovered in this field in 1889, reached a peak of 33 million barrels in 1910, and then declined. It is now being steadily and scientifically developed, the annual average production showing an increase of over 50 percent. The oil field has been declining steadily in importance and today yield only about 5 percent of the national output.

The great Midcontinent field

The most productive oilfields of the United States are those on the eastern side of the High western Prairies in the south Pacific Railroads in Rio Grande del Norte valley forming a belt stretching upto New Mexico, in which the well known oil field of Mid continent occurs, through Texas and Oklahoma, across the Canadian river in to North East, where Little Rock is situated, and up into the Mississippi. In the South eastern portion this belt coincides with the site of the Gulf coast belt. At the present time the great Midcontinent field is producing more oil than all other fields in the U.S. combined.

Texas was the principal oil-producing state of the U.S. in 1953, accounting for 43·4% of the total. Bartlesville, Glenn, Kilgore, Corsicana and Neodesha are the five areas which alone have so far proved of real economic importance. The principal products marketed from the Mid continent area are petrol, lubricating oils, paraffin wax, asphalt base and a comparatively low grade of kerosene suitable for market consumption. It has 50 percent, of the proved reserves of the United States.

The Gulf coast oil field

Oil is found at Spindletop in Texas and near Beaumont, and refined at Lake Charles in Louisiana, on the Calcasieu River, 46 kilometres from the gulf of Mexico. This huge petroleum refinery at Lake Charles works day and night throughout the year. After Midcontinent field Gulf coast oil field is the second largest in the United States.

The Rocky Mountain oil field

Many oil producing areas are scattered throughout this large region, which extends from central New Mexico to the Canadian border. The chief supplies of oil come from wyoming, which is also noted for silver and gold. Wyoming ranked sixth among oil producing states of the United States. The production of petroleum has increased from 30 million barrels in 1930 to a record 90 million barrels in 1960.

CALIFORNIA OIL FIELDS

Oil springs are known in various parts of California, the most prominent being those appearing in the Los Angeles and Bakersfield areas. Commercial oil comes from the Los Angeles and Kern and Orange countries.

Canadian Petroleum Resources

The first petroleum well as drilled in 1859 at Titusville. Production in the Canadian west was begun in 1941 and increased rapidly after the discovery of the Turner valley in southern Alberta. There are reserves of various kinds of oil and gas in the western, North west and some of the middle provinces but later discoveries were made in 1939 at Lloydminster near the Saskatchewan–Alberta boundary. Alberta ranked high among the oil producing states of Canada, which accounts for about 95 percent of the nation's output. The output is sent by pipeline to Superior. The second pipeline was in 1953 from Alberta to Vancouver over the Rockies.

Norman wells in the Mackenzie valley near the Arctic circle started to produce oil in 1920. This valley has oil resources which may lead to future industrial activity, but most of them have as yet been little exploited. The 'fabulous tar sands' of the Lake Athabaska region has by far the largest proved reserves in the Canadian territory. This fabulous tar sands contain 200 billion barrels of petroleum deposits.

MEXICAN PETROLEUM RESOURCES

Extending from the Southwest corner of the state is the New Mexico section of the Midcontinent oil field, which, with a small section in Mexico, furnished nearly all of the country's supply of petroleum for several years following the discovery of its value for illuminating purposes. Less than one-fourth of Mexican oil is now exported. Since 1921 Tampico on the Gulf of Campeche is the word's leading oil port.

SOUTH AMERICAN PETROLEUM RESOURCES

Venezuela,'Colombia and Peru contain the most productive oil wells in South America. There is an extensive area in the north-western part of the country containing oil-shales and sand-bar.

The only commercial production of petroleum in Venezuela itself, so far, occurs in three areas, one in the Maracaibo Basin, the second in the Orinoco Basin and the third in Apure Basin.

Maracaibo Basin

In Maracaibo basin petroleum is being produced from seven fields. Mara, Tarra, Mene Grande, La Salina, Tia Juana, Bachaquero and Lagunillas being the leading producing centres in this basin. Almost 73 percent of total Venezuelan production comes from this oil field. There are series of wells in Maracaibo basin, the oil is transported to the coastal refineries at Coro and Maracaibo in Paraguana peninsula and then transhipped to the islands of Curaçao and Aruba in Caribbean sea—a Dutch territories.

The Orinoco Basin Fields

West of the plains of the Orinoco, and separated from it by one of the Andean ranges, lie the lowlands round the Gulf of Venezuela. Here and on the lower slopes of Parime ranges the second richest oil producing fields are situated in Venezuela. Principal oil producing fields are at Quiriquire Jusepin and Oficina.

The Apure Basin

It is situated to the South of Maracaibo basin and western continuation of the Orinoco oil field. Important centres are at Portuguesa Barinas and Apure. Only 2 percent is now produced in this basin. Fig. 11·4 shows the oil resources of Carribean region.

Colombia consistently ranks second to Venezuela in the value of production, which increased from 40 million barrels in 1955 to 56 million barrels in 1960, declined to 50 million in 1962 but rose in 1965 to 53 million barrels. In Colombia two thirds of all oil production occurs around Barrancabermeja. A Second producing field is the Catatumbo in the Barco concession bordering on Venezuela.

Though potentially rich oil fields are suspected in various parts of Peru and chiefly in the Puno region, as well as in the Montana sector, actual exploitation is almost exclusively limited to the northern coast. Nearly 16 million barrels of crude oil were produced in 1953, approximately 70% of which was by the International Petroleum Company, less than 30% by the Lobitos Company and about ½% by the Government-Controlled Compania Petrolera Fiscal and the Ganso Azul company. The last mentioned is the only company to operate in the Amazonian region. A constant rise in domestic consumption was responsible for a marked drop in petroleum exports of about one-third after 1949. Crude oil is also produced at Talara in nothern Peru, around Santa Cruz in eastern Bolivia, and on the Santa Elena peninsula of Ecuador.

In Argentina petroleum is being produced from four areas :

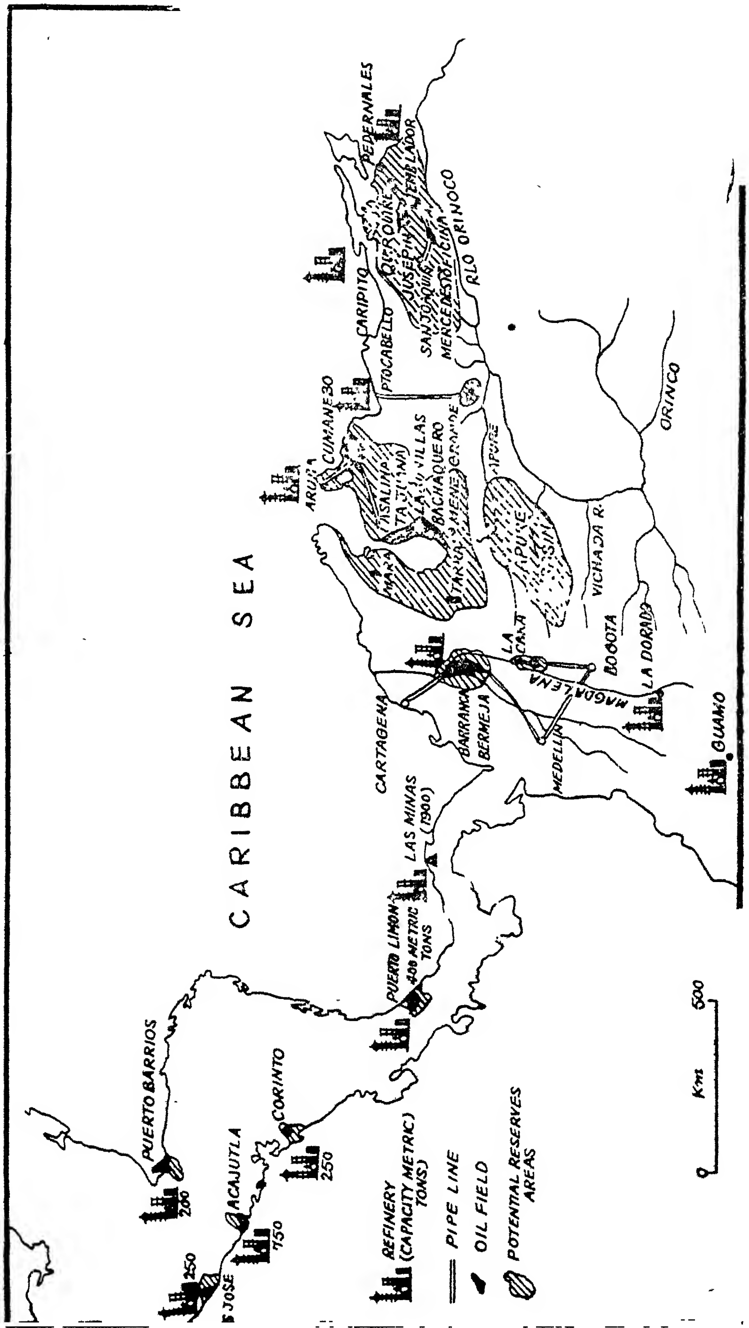


Fig. 11·4. Oil fields of Carribean Region

(*a*) in Extreme northwest near Salta, (*b*) a few kilometres east of Andes near Mendoza, (*c*) Neuquen area, and (*d*) Comodora Riva-pavia. Argentina's annual production of about 25 million barrels, chiefly in the Comodora Rivadavia field, meets two thirds of her needs.

In Chile petroleum was discovered late in 1945 at Cerro Manantiales and San Sebastian on Tierra del Fuego ; commercial production began in 1950. Development of field entiled the construction of a 41 kilometres pipeline from the producing area to a port and of submarine lines at Bahia Gente Grande (Caleta-clarence) for loading oil at deepwater stations.

EUROPEAN PETROLEUM RESOURCES

Europe is not fortunate enough in possessing rich reserves of oil . The total oil resources of European countries were estimated at 2,820,741 thousand barrels in 1960. Europe's share in these reserves works out to less than 1 percent and accounts for 3 percent of the world output. Practically 36 percent of the Petroleum supplies of Europe are derived from south-central Europe which is found in Rumania. Beginning with the year 1949, the State planned to raise, in as short a time as possible, Rumania to the level of the developed countries. The long-term state economic plans are for a five or ten year period. At the 10th Congress of the R C.P., held in August 1969, the directives of the five year plan for 1971–75 were issued.

The volume of funds invested for the social economic development of the country is growing every year. Between 1951–72, the vloume of investments in the economy amounted to 822·2 thousand million Lei, (422·6 thousand million Lei in industry)*. 314 thousand million Lei were invested in the economy during the five-year Plan 1966–70, of which 165 thousand million Lei went into industry. In view of the great need to establish indigeneous sources of oil in Rumania, the nucleus of an organisation for oil exploration was set up by government of Rumania towards the end of the Five-Year Plan period. The production of Petroleum is shown in the table 11·1.

Table 11·1

Petroleum Production in Europe

Figures in Lakh metric tons

Country	1966	1970	1972-73
Rumania	115	132	141
W. Germany	55	73	N.A.
France	20	23	N.A.
Austria	24	28	N.A.
Yugoslavia	9	25	32
The Netherlands	19	20	23
Hungary	12	18	19

* Lie=1 26 Indian Rupee. N.A.=Not available.

Italy	20	15	N.A.
Poland	N.A.	5	39
Bulgaria	N.A.	5	2
Czechoslovakia	N.A.	5	2
Albania	N.A.	1	6

Northern Europe

This comprises the Scandinavian block of Norway and Sweden, Denmark, Finland and Iceland. North Europe have no oil, and must look to its forests and waterways for source of energy. The oil shales occur around Narke in the central lowlands of Sweden, and from the shale 50,000 tons of oil a year are distilled at Kvarntop. The ancient metamorphosed rocks of Northern block have numerous and varied mineral deposits but poor in mineral fuels.

Western Europe

This division includes Netherlands, Belgium, Luxembourg, France and the British Isles. Oil is found at Schoonebeck in Drenthe and near The Hague, and refined at Pernis near Rotterdam in the Netherlands. The annual output, over 2¼ million tons in 1967, is only 30 percent of requirements. The refineries at Pernis, however, deal with large imports and re-export petrol and petroleum products. An oil pipeline is in use between Rotterdam and the west German Rhine.

The oil fields of France are in three groups. The most important is the North-East or Alsace oil field. There are several producing regions near the Pechelbronm.

The Second richest producing oil fields in France are to be found in Parentis. The Parentis field, in the Landers, after a slow start, is now a major producer. Lacq, besides having the largest output of oil, has natural gas, which is piped to Paris.

The third producing field is the St. Marcet. It is situated along the flankes of the Hills of Pyrenees. St Marcet field east of the Pyrenean foothills, has ceased to produce oil, but its output of natural gas is greater than that of Parentis and Lacq combined.

Central Europe

It contains the countries of Germany, Poland, Switzerland, Austria and Czechoslovakia. In 1930 oil was discovered north-east of Vienna in Austria, and today derricks surround the villages of Zistersdorf, Gansemdorf and Durnkrut. The oil field is claimed, probably optimistically, to be one of the largest in Europe. Its output—at present about 2·5 million tons annually—is of the greatest importance to Austria, in view of its shortage of solid fuel. Much of the oil is surplus to the country's requirements and is exported, largely in exchange for coal from Germany.

In Poland, mineral oil is extracted in the sub-Carpathian region around Krosno and Jaslo, but Poland's petroleum deposits are

small. It contributed only one-third of the country's requirements. The deficiency is supplied by the Soviet Union.

South-Central Europe

The countries of South Central Europe are here taken as being Hungary. Rumania, Bulgaria and Yugoslavia. To the South, in the Zala valley in Hungary, an oilfield with natural gas developed in the past twenty-five years, is connected by pipeline to Budapest. Nagykanisza is the centre of the oilfields, and has glassworks and petroleum refineries. In the Transylvanian foothills of Rumania are large deposits of petroleum and natural gas. The oilfields are around Tirgu Jiu and north of Ploiesti, in the Walachian Podgoria and west of Bacau, in Moldavia in Rumania. There are oil refineries in Walachia at Ploiesti and Brazi, and at Borzesti in Moldavia, all are in Rumania. A pipeline carries crude oil from Ploiesti to Constanta, a port on the Black Sea. Outside the Soviet Union, Rumania is the Europe's greatest producer of oil and second producer of natural gas. Methane gas occurs south and west of Ploiesti. A large proportion of Rumania's methane is used in the generation of thermal electricity. In Yugoslavia a small oilfield South-east of Zagreb yields 1·5 million tons of petroleum a year, and there are deposits of natural gas in the same region. Fig 11·5 shows the possible oil belts of Europe.

Southern Europe

This comprises the three great peninsulas of Iberian, Italy and the Balkans. A small oilfield is located near Piacenza in the Plain of Lombardy in Northern Italy. In 1945 enormous deposits of methane gas were discovered at Caviaga near Milan. Methane gas is distributed by pipeline throughout northern Italy, where the gas is utilized as fuel. In Insular Italy or Sicily, oil first discovered in 1953, is exploited at Ragusa, Gela, Fontanarossa, Caltanissetta and Enna. Albania has sufficient oil for its present requirements. There are several producing regions in Dsicordant coast and Concordant coast of Albania near Adriatic sea.

PETROLEUM RESOURCES OF THE U.S.S R.

The Soviet Union takes one of the first places in the world for oil reserves. The output of oil has greatly increased in the Soviet period : in 1940 it was 3·5 times as much as in 1913; in 1955 it increased almost eightfold as compared with the same year. By the end of 1955 the total oil production of the U.S.S.R. had exceeded the pre-war level more than twofold. A series of new oil pipelines and of new refineries near oil-consuming centres, have been built in recent years. The chief oil producing areas are :

1. The Caucasus oil fields

The oil fields are mostly located in Trans Caucasus region of U.S.S.R. Trans-Caucasian oil plays a very important role both in the domestic consumption of the U.S.S.R. and its exports. In the national economy of Trans Caucasia the oil industry of Baku takes a leading place. Oil is Trans Caucasia's chief contribution to the national economy of the Soviet Union. The greatest of Russian

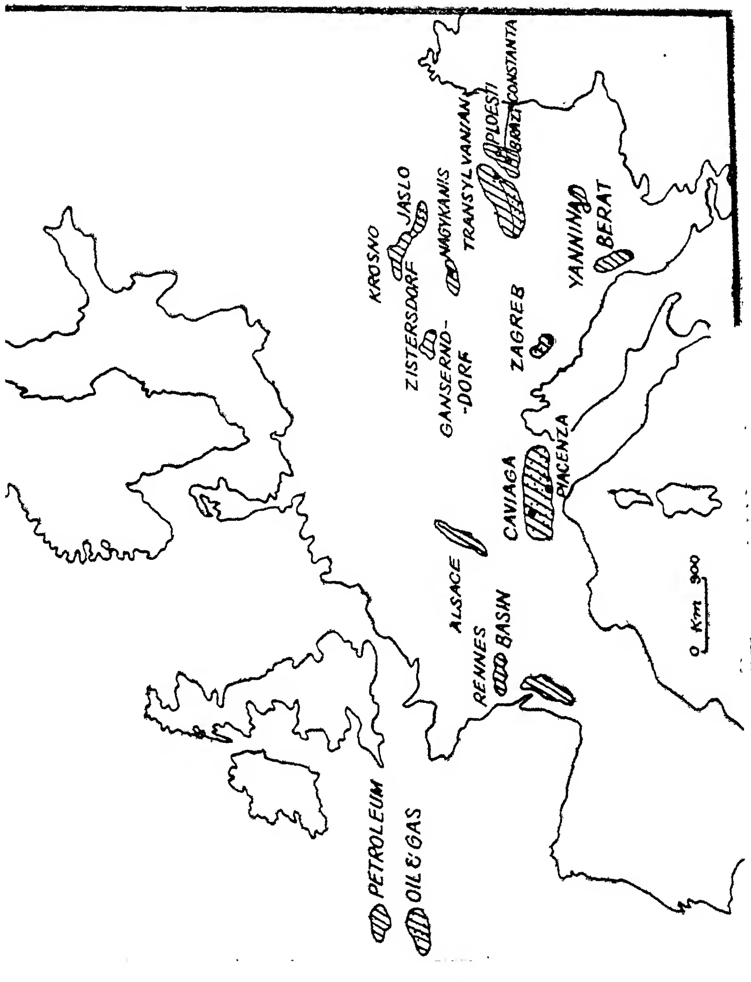


Fig. 11 5. Possible oil Producing areas.

oil fields is of Baku field on and near the Apsheron peninsula along the west coast of the Caspian Sea.

The oil industry of the Apsheron peninsula, which is not only of national but also of world importance. Thus, oil has been found in Apsheron peninsula mostly in Binagady, Balakhany, Ramny, Sabunchi, Buzovny, Surakhany, Baladzhary, Puta, Bibi-Eibat, Baku and many other places. Baku is the oldest oil producing region. From 75 to 83 percent of Russian oil comes from Baku. In addition to the old fields of Balakhany, Surakhany and Bibi-Eibat new regions were found after the Revolution of 1917 and the oil-fields as well as the port itself have been developed beyond recognition.

Similarly, North-Caucasian oil mined in Grozny and in the Maikop district is supplied not only to the North Caucasus but also to the Rostov and Kamensk regions. Dozens producing centres are scattered all over the northern Caucasus region. Most of them are located at Nefregorsk, Derbent, Tuapse, Kirovabad, Tiflis, Novorossisk, Yeisk, Batumi, etc. Grozny is the second of an oil-mining district, which ranks second after Baku from its output. Besides oil mining and oil refining, Grozny is known for its manufacture of equipment for the oil industry.

Oil goes from Baku in two directions : either to the north by the Caspian Sea, through Astrakhan to the Volga, or to the west–to Batumi (formerly Batum) through pipelines. Baku is connected by oil pipe-line with Batumi, and from another port, Makhach-kala, a pipe line runs to Grozny, Armavir and Tuapse. Baku itself has a large refinery capable of treating over 300,000 tons of oil yearly. The oil pipe-line from Baku to Batumi and the huge modern refineries have made it the chief port fot exports of oil. Much of the Russian oil and by–products of petroleum are also Trans-shipped from Batumi.

2. Volga-Ural Region

Besides the Caucasus, oil is extracted along the western slope of the Urals and in a number of areas in the Volga region. A new oil region, which includes newly discovered oil deposits between the Urals and the Volga, has been created and given the name of "Second Baku".

The rich petroleum deposits are to be found along the entire length of the Ural Mountain ranges. The principal oil producing areas are Syzran, Kuibyshev, Bugulma, Buguruslan, Ishimbai, Tuimazy, Shugurovo, Krasnokamsk, Bolshoi-Cheremshan valleys and many other places.

Oil extraction from newly discovered deposits of "Second Baku" and oil-refining in Saratov, Kuibyshev and Syzran have in recent years assumed great importance. Being situated in the immediate proximity of consuming centres, this oil region assumes exceptional economic importance. Second Baku oil field greatly facilitates the oil supply of the eastern regions.

3. North-Eastern Carpathian Foot Hills oil fields

The Transcarpathian part entered the Ukrainian Soviet Socialist Republic in 1945, it is a very small region. In the foot-Hills of the Carpathian arc are large deposits of petroleum and natural gas. This region is also known as Moldavian Soviet Socialist Republic. The oil fields are found in Chernovtsy and North of Stray and east of Borislav and Drogobych in western Ukraine. There are refineries in Borislav and Drogobych. A pipeline carries crude oil from Trans-carpathian field to Odessa, a port on Black sea.

4. Kerch Peninsula oil field

The Kerch peninsula in the east of the Crimea stands out for its mineral resources, which includes enormous deposits of Combustible gases and oil having national importance. Kerch is a sea port, situated at the Kerch strait. It is a centre of oil refineries and important oil port.

5. Izhma valley oil field

Oil is extracted along the valley of Izhma in the north east of the European part of the Soviet Union. The Izhma valley oil and gas are supplied to Leningrad with which the oil field is now linked up. The growing extraction of Izhma valley oil has given rise to the new towns of Vorkuta and Ukhta and they were connected by a railway line with the Arkhangelsk—Vologda rail road via Kotlas.

6. Kazakhstan oil field

The Emba valley oil producing region near the north east-north coastof Caspian sea takes a prominent place in the Soviet Union for its oil reserves. The Emba valley oil fields have been greatly extended and provided with transport facilities. Three oil centres along with refineries stand out in the Emba valley field—Koschagyl, Dossor and Makat. The Kazakhstan field has by far the largest proved reserves in the Soviet Union, and production has not even approached its zenith. Fig. 11·6 shows the oil fields of the U.S.S.R.

Sakhalin oil field—There are deposits of oil and gas. North-east Sakhalin is most productive region. Okha is major producing centre with many refineries.

CHINESE PETROLEUM RESOURCES

Oil reserves in China have always been greatly under estimated. The known oil reserves in China have been estimated at 778,855,000 tons, including 520,000,000 tons of oil shale. The major production is at Yummen in western most Kansu near the foot of the Nanshan hills. Both Kansu and Sinkiang may prove to be important, but they are economically remote from the main market. In northern Shensi and Szechwan, there are small oil wells. Production at Wusu, west of Tihwa and north of the Tien Shan, began in 1935 under the Soviet direction.

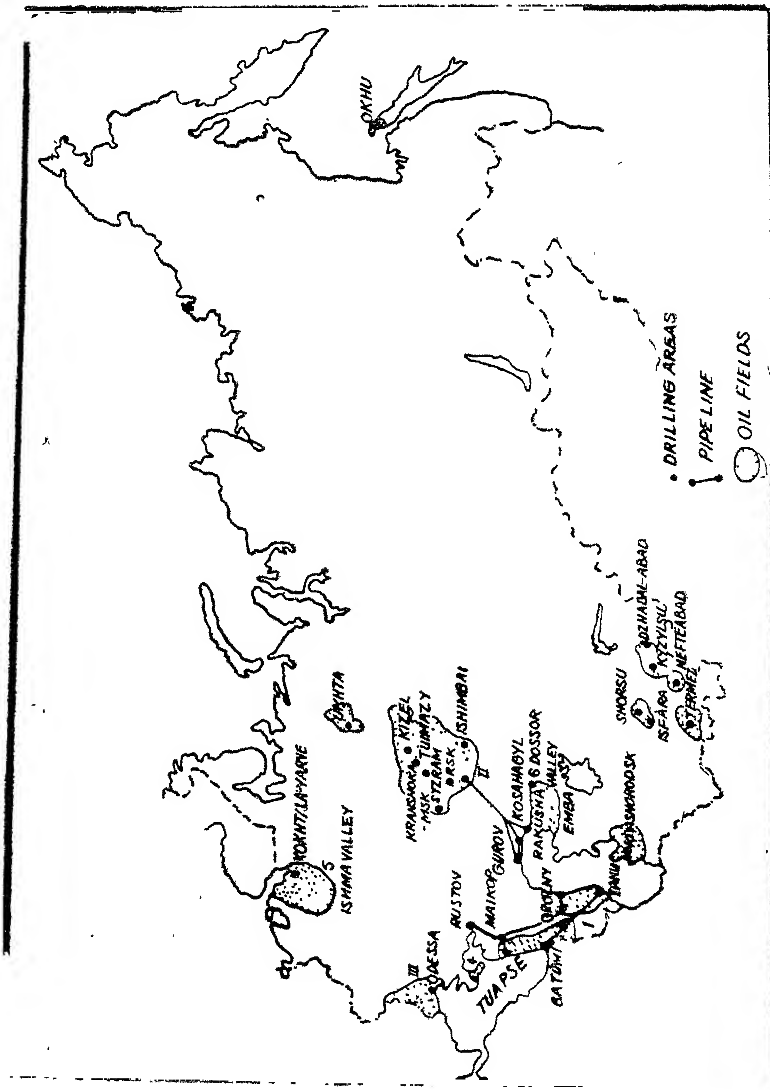


Fig. 11·6. Oil fields of the U.S.S.R.

JAPANESE PETROLEUM RESOURCES

Oil occurs in north-west Honshu and can be easily shipped from the excellent harbour of Niigata and other parts. Oil flields are in two areas :

(1) North western Honshu

The western part of the northern Honshu includes the Japan's two principal oilfields—the Niigata and Akiita. From these two oil fields 95% of country's domestic oil suppily is derived. The Akiita field is located in a north west coastal belt about 170 kilometres long and thirty to fifty kilometres wide. The Akiita field comprises six to ten producing districts, most of which are located in hilly Tertiary rock areas at some distance inland from the coast. The second important field is Niigata in north-western Honshu. It extends some 320 kilometres north-south along the Japan sea coast and is fifty to sixty kilometres wide. The Niigata field was developed much earlier than the Akiita field to the North. Fig. 11·7 shows the oil fields of Far East.

(2) Hokkaido oil fieds

There are several oil producing regions along the northern shore of sea of Japan. Only two districts, the Ishikari and the Iburi, yielded significant amounts of crude oil since 1935. Ishikari field is situated in a hilly tract about eight kilometres north east of the town of Ishikari and north of slightly east of Sapporo. Iburi is situated some sixty kilometres south and east of Sappora and about ten kilometres inland from the coast.

PETROLEUM RESOURCES OF S. EAST ASIA

Asia outside the south-west can cliam only 4% of the world oil reserves. South East Asia's share in these reserves work out only 3 percent. The only known south-eastern Asia oil fields are those in Sumatra at Palembang. Some new oil fields at Plaju, Jambi and Atjah in east coast of Sumatra were discovered recently. The newly discovered oil producing fields of Sumatra lie across the strait of Malacca opposite Singapore. Borneo's principal oil producing fields lie in Northern part of Trakan Island, Sarawak and at Balikpapan, Angana and Samboja region. The oil fields in Borneo are not located where most of the people live nor where the largest markets for petroleum products are found.

Java produces oil on both—north and south—sides of the Madura Island, though most commercial production has occurred in the extreme north east along the Java sea near Surawaya. Rambang and Sorawaja

The most productive oil fields of Burma are those on the eastern side of the Arakan Yoma in the Irrawadi valley forming a belt stretching from below the Magwe district, in which the well-known field of Yenangyaung occurs, through Myingyan which contains Singu, across the Irrawadi into Pakokku, where Yenangyat is situated, and up into the Chindwin district.

Yenangyaung, Singu, Yenangyat and Minbu are the four areas

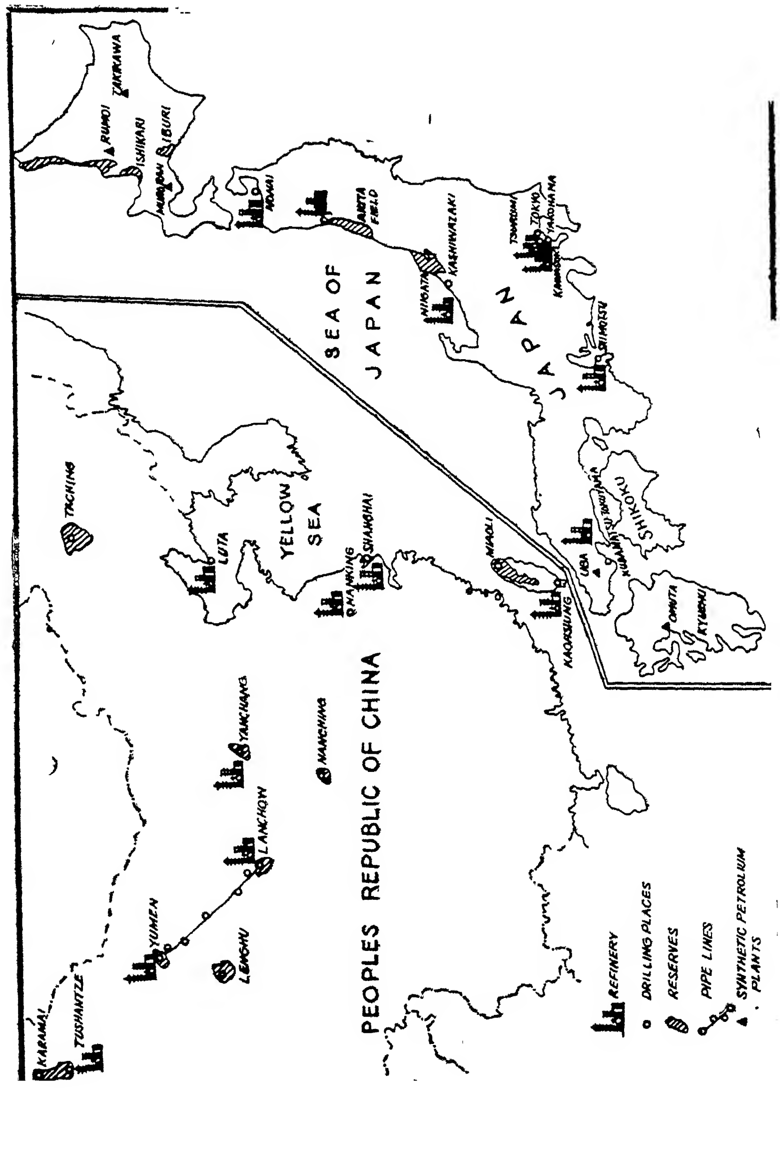


Fig 11 7. Oil fields of Far East

which alone have so far proved of real economic importance. Besides the upper Burma oilfields, the islands off the Arakan coast have also been known for many years to contain oil deposits of uncertain value.

SOUTH ASIAN PETROLEUM RESOURCES

This division includes India, Bangla Desh, Pakistan and the Himalayan kingdoms and Ceylon. The petroleum resources of Southern Asia are confined to the two systems of folded rocks at either end of the Himalayas and are :—

(*a*) The Iranian system of the west including the Panjab Sind and Baluchistan and continued beyond Persia and Mesopotamia, where the oilfields have attracted interest for many years.

(*b*) The Arakan or Shan system on the east, including Purbanchal territories of Indian Republic and Burma, with their Southern Geotectonic extension to the highly productive oilfields of Sumatra, Java and Borneo.

Such rocks are found in India along the Southern margin of the Himalayas and also on both sides of the mountain chains along the Sind Baluchistan border and the Assam-Burma border. Those of the Himalayan region are highly folded, broken up and thrust over each other, and it is doubtful if any important oil deposits will be found in them, except isolated structures.

In North Eastern India, oil has been successfully won in the Digboi and Badarpur fields to a restricted extent and for short periods in the Masimpur and Patharia fields The Digboi field is the only one still under production whilst the Badarpur field has been abandoned since 1933. At present the entire output of India comes from the Digboi field which has been producing for over four decades. It is, however, showing definite signs of declining output during the last decade. In the meanwhile, a considerable amount of drilling has been done in NEFA and Assam. This area is separated from the Digboi field by the well known thrust fault called the Naga thrust, but is entirely covered by thick alluvium and late Tertiary sediments.

The most suitable geological formations for the search of sources of oil in India are the Tertiary areas. Search in the Himalayan region is not likely to be encouraging, as already mentioned. In Northern Purbanchal, however, geological conditions are somewhat more encouraging, though even here the Tertiary formations have been subjected to much thrust faulting from the side of Burma.

In addition to these, there are comparatively small areas along the coast where there are patches of sedimentary rocks which may possibly contain oil. On the western side of India the region of Jaisalmer, Kutch and Gujrat have possibilities because they contain Mesozoic and Tertiary sediments of some extent and thickness Along the eastern coast of India, there are only small areas which

include the Mahanadi delta and some Tertiary rocks on the Tamil Nadu coast. If is not known, however, whether these contain any suitable structures for acting is reservoirs of petroleum but suitable geophysical surveys can be made for finding out the possibilities.

Oil-springs are found in various parts of Purbanchal, the most prominent being those at the Southern foot of the Khasi and the Jaintia hills and those appearing in the coal-bearing rocks in north-east Assam, especially in the Lakhimpur district. Oil is also obtained from the Lakhimpur district, where systematic drilling is conducted at Digboi. Here the important oil centres are Digboi, Bappapung and Hansapung. In the Surma valley some oil of poor quality is found in Badarpur, Masimpur ánd Patharia. Naharkatiya is also important centre in Assam.

In the Panjab, on the other hand, it is the Nummulitic which is the predominant oil-yielding series, and although the only supplies which have so far proved of economic importance are found in the series above, there is good reason to suppose that the oil has migrated up from the Nummulitic below.

Western Region of India

The development of petroleum in the Cambay lies chiefly in the future, for the region is least accessible to the nations leading markets. Many prôducing fields are scattered throughout this western region, which extends from Rajasthan to the Maharashtra border. Cambay has the largest proved reserves in this region. As a consequence of new exploration and deeper drilling, production in the western Region, particularly in Cambay, has trebled since 1957. Fortunately, thousands of hectares of oil land are owned by the Union Government of India which may render great service in future.

On the basis of results of geological and geophysical surveys drilling has been in progress in a number of States of the Indian Union, particularly in Gujrat and Assam. As a result of this drilling, oil and gas have been found in a number of areas of which the most important are at present the Cambay gas field, the Ankleswar, Kalol and Nawagam oil fields in Gujarat. The Nawegam-Koyali sector of the Kalol-Nawagam—Koyali trunk oil pipeline was commissioned in Sept. 1971. With the commissioning of this pipeline, transportation of oil from the Nawagam oilfield of ONCC to the Royali Refinery by road tankers has ended and oil now flows to the refinery through this pipeline This is the first indigenously designed long-distance oil pipeline, which crosses four rivers, many road culverts and gorges on its way. The pipeline is a vital link between the North Gujarat oil fields and Koyali refinery.

A number of pipelines are proposed to be laid down to connect Gauhati and Silguri, Calcutta, Haldia and Barauni, Kanpur and Barauni and Gujarat oil fields with power stations and other consuming centres.

Oil was struck at Aliabet. India's first off shore drilling project which would lead the State to the highest peak of prosperity. It was a major break-through in the country's sea oil exploration programme, launched at Aliabat, in the Gulf of Cambay, 45 kms. from Bhavnagar. The oil was struck at a depth of 820 metres from the surface.

Meanwhile, steps have been initiated for the second off-shore oil product in Bombay High, over 160 kms off the west coast of India. Most of India's sedimentary basins lie on and around its coasts. The geological formations in the Gulf of Cambay, now widely known as the Bombay High, are believed to contain rich oil deposits. This was confirmed by a survey, done by a Soviet team in 1964-65 which mapped several promising structures including one in the Gulf of Cambay and another off the coromandel coast Of the two, the "Bombay High" structure is the more promising, spread over a thousand square kilometres, 20 times the size of Ankleshwar. A geologist described this geological formation as "mouth watering." The oil company that has been most persistent in its desire to explore the area, Tenneco—Amercian company—is certain that if oil is found—and with oil, this is always a big 'if' regardless of how mouth watering a geological formation—it will be in sufficient quantities to make India self-sufficient, if not a marginal exporter.

SOUTH-WEST ASIA

The World Oil Committee estimated the total reserves of oil in Middle East for 93,265,000,000 bbl. or over 60% of total world reserves, while Wallace E. Pratt placed this figure at 121,700,000,000 bbl. or about 70% of the world total.

As it was previously stated that occurrence of oil is known to be related to sedimentary areas. The major oil fields are to be found in the sedimentary basin in the half dozen countries around the upper end of the Persian Gulf. The search for oil has made the southwest the best-known region. In middle Cretaceous times intensive folding affected the Persian Gulf area and narrowed the Tethys geosyncline, but heavy sedimentation still went on toward Mesopotamia. Upper Cretaceous deposits, mainly Asmari limestones being laid down in the southwestern region to a thickness of 1000 metres. Oil occurs in the shallow anticlines of the foothills on the Mesopotamian margin especially in the basin of the Karun river in Iran, and southern Foothills of Kurdistan ranges in Iraq, as shown in Fig. 11·8.

Iranian Resources

Petroleum occurs in places and is being largely developed in the Karun valley and behind Bushire. The reservoir rock is the fissured Asmari limestone which is capped by the shales of the Fars series, both of Miocene age. Geological and topographic conditions make the exploitation of the deposits cheap and easy. Few wells are needed to work the field, and gas and

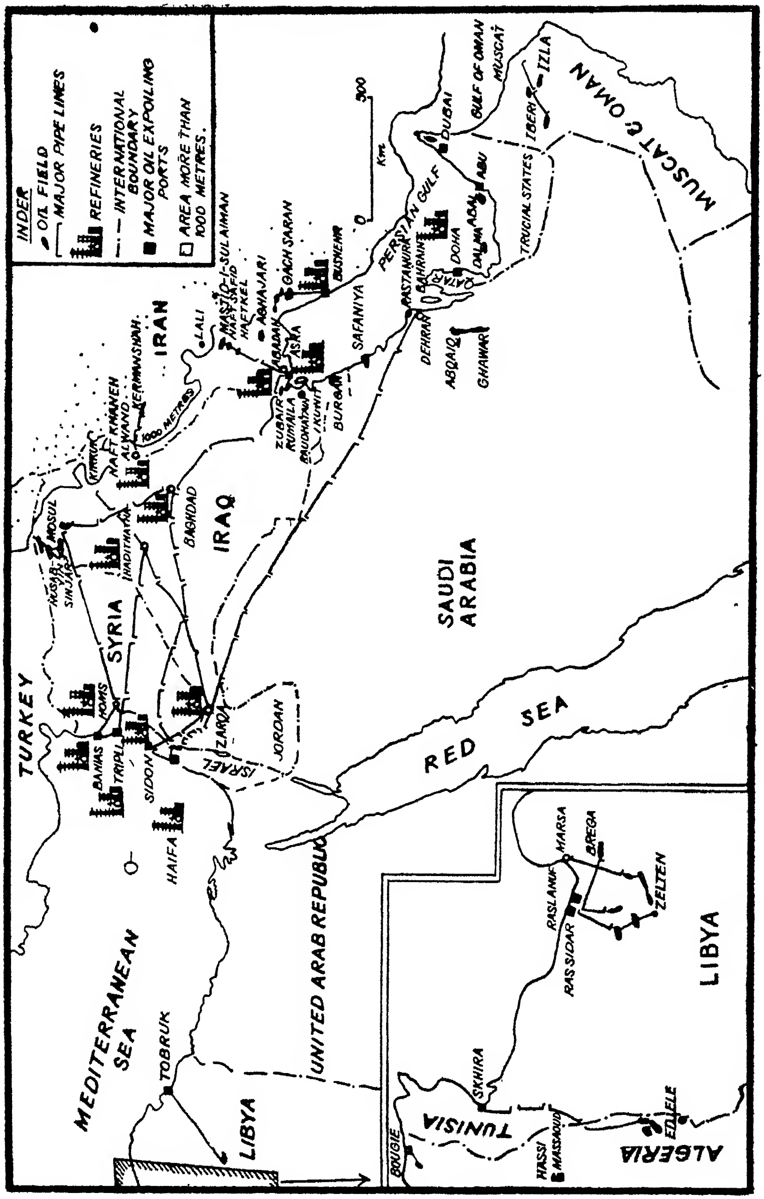


Fig. 11·8. Oil fields of Middle East

water pressures make pumping from the bores unnecessary. With careful siting of the pipe lines the oil flows under gravity alone to the refining centre at Abadan. A lesser field is exploited west of Kermanshah for local needs. The principal localities engaged in oil production are given below :—

Karun valley fields

The valley is rich in petroleum. The important producing centres are Gach Saran, Pazanun, Aga Jari, Ahwaj, Khuramshah, etc. The greatest oil centre is in the south-west, the oil is led in a 3·5 metres pipe to Bushire on the Persian Gulf. The wells are under the control of an Anglo-Persian company—a British company later know as Anglo-Iranian Oil Co. (A.I.O.C.) A bill for the nationalization of the oil industry was brought in and passed and the National Iranian Oil Company was set up to take over the A.I.O.C.'s interests. But under the National Iranian Oil Company's administration production and refining were greatly reduce and exports practically ceased. In 1955 the National Iranian Oil Company signed contracts with a British and French firm for a 25·4 cms products pipeline from the Karun valley cil fields to Tehran.

Zardah-Kuh and north western Highlands oil fields

In both the areas oil is associated with Tertiary strata, and has had probably similar conditions of origin in both cases. Oil springs are known in various parts of Zardah-kuh especially in Masjid-i-Sulaiman, Naft safid and Haftkel, and those at the Southern foot of the north western Highlands of Iran. Marketable oil comes mostly from the Masjid-i-Sulaiman field. Pipelines link the chief fields with the nearby port of Abadan, site of the world's largest refinery, which has a capacity of 540,000 barrels a day. Naft-i-Shah and Kermanshah oil fields are situated in the north western Highlands of Persia.

Iran's production of petroleum was only 2 million barrels per year in 1913, it increased to 66 million barrels in 1939, to almost 242 million barrels in 1950.

IRAQ

Iraq is very fortunate in possessing rich reserves of oil. Her present average production, 355 million barrels, which gives Iraq sixth place among the world's oil producing countries. Oil has long been known to be present, and where efforts to obtain it in marketable quantities, after many failuers, have been crowned with success by the discovery of the Baba Gurgur oil field in northern Iraq near Kirkuk. The nothern part of the country and the Kurdistan Hills generally are situated in an oil-bearing belt of Tertiary age common to Persia and the world. The oil fields of Iraq can be grouped into two categories. They are as follows :—

Northern Oil Fields

In the Southern foot hills of Kurdistan mountain arc are large deposits of petroleum and natural gas. In northern Iraq there are

number of oil fields. The most important of these, the Kirkuk oilfield, occupies a hilly basin—like area of Tertiary rocks in the extreme north of Iraq. Somewhat farther to the north-west are several other less important fields : such as Qasar, Ain Zalah, Jawan, Najmah, Qaivarah, Baijii. etc. The three—Naft-khaneh, Khanaqin and Chia Surkh—all are situated on the Iranian border South-east of Kirkuk oilfield. There are oil refineries in North oilfields at Kirkuk, Baijii, Khanaqin, Mosul and Baghdad. A pipeline carries crude oil from Kirkuk to Tripoli via Haditha, a port on the Mediterranean sea. The second pipeline from Haditha led to Haifa through out the northern part of Jordan and Israel, was constructed by I. P. C.

Near the head of the Persian Gulf Oilfields

Iraq's petroleum belt lies along the Persian Gulf coast from Kurdistan mountains on the north, through the central plain of Mesopotamia, to about parallel 30° on the north. The southern is composed mainly of clay and sand. The Southern part of Iraq near the head of the Persian Gulf includes the country's three principal oilfields–Naur Umr, Rumailia and Zubair. The Zubair oilfield has been rapidly increasing in importance since 1949. A pipeline was constructed from Zubair to the port of Fao at the mouth of the Shatt-al-Arab.

South-west-north Countries of Persian Gulf

South-west-north countries of Persian Gulf may be said to comprise the two small peninsulas of Musandan and Qatar, which project northwards into the Persian Gulf sea, and the islands which lie off their coasts. It includes the countries of Kuwait; Saudi Arabia, Qatar, Bahrein, Trucial Sheikhdoms and Sultanate of Muscat and Oman, and dependences of Gwadar and Dhofar. The Trucial Sheikhdoms comprises the dependencies of the Ras-al-Khaimah, Umm-al Qaiwain, Ajman, Sharja, Dubai and Abu Dhabi. In structure, too, Trucial Sheikhdoms must be regarded in many ways as merely a South eastern extension of features found in countries to the north west, not a physical or structural region in its own right. Nevertheless, within Sheikhdoms there are so many resemblances in social, cultural and in economic behind political ambitions. It was this recognation of common economic and political interests that brought about the association of these small dependencies and the name of Sheikhdoms, and later helped to give birth to the Trucial States, of which they are all members.

The prosperity of the Sheikhdoms was transformed by the discovery and exploitation of oil which, directly and indirectly, affords the main source of revenue. Oil was not yet in production on the Trucial coast at the beginning of 1955, but strikes at Bahrein (1934), Quatar (1949) and the refinery at Bahrein, processing large quantities of crude oil from the Saudi Arabian fields on the mainland, had already brought wealth in which less fortunate neighbours shared to some extent.

Dukhan on the west coast and Umm Said on the east coast are the major producing fields in Qatar peninsula. Qatar peninsula produces about 33 million barrels of crude oil a year. The Bahrein group of islands is ruled by a Sheikh whose relations with the British government are governed by a series of agreements dating back to 1880. This island produces about 11 million barrels of oil per year.

Many oil producing fields are scattered throughout the north eastern and north western regions of Saudi Arabia, which extends from Qatar peninsula to the Kuwait border, in the north. Saudi Arabia has the largest proved reserves in this region. The first oil strike was made in 1936 in the Dhahran field near Ras Tanura. In 1950 a 2600 kilometres pipeline was completed across the vast desert, linking Ras Tanura with the port of Siden, on Mediterranean sea, and its refinery at Siden processes local oil for export. Other important oil producing centres are Damman, Qatif, Abqaiq, Ghawar, Haradh, Abu Hadriya, Fadhill, Nariya, etc.

Kuwait ranks fourth among the oil-producing nations of the world. Every centimetre of Kuwaits territory, is regarded as world's most valuable piece of land and it possesses the world's largest proved reserves. The great Burghan oilfield with a refinery, is operated by a British American company, and "the royalties received by the ruling Sheikh make him one of the world's richest men "[1] Kuwait and Magwa are other important oil producing fields in Kuwait. In 1946 Kuwait exported oil for the first time, whereas in 1969 total production, including a half share in the Neutral zone, totalled 141 million tons. Oil revenues to the state have mounted in step with rising oil production: revenue payments in 1968 alone amounted to 773 million dollars.

The oil rich Arab countries have been earning startlingly large revenues from the precious liquid. The Arab Governments have to determine how much of this Astronomical income can be absorbed by their economies. Extensive social welfare and nation-building programmes are at hand in Kuwait, Saudi Arabia and other oil-rich Arabian countries, but even with massively increasing spending on development and welfare, these governments have accumulated huge reserves of dollars, a major portion of the oil earnings of the Arabian countries have been going to boost the funds of the Inter-Arab Development Bank.

GEO-STRATEGY OF OIL

Oil from the Middle East had suddenly become a top factor, and a dangerous one, in international politics. The western world is making to expand and deepen relations with countries within or around the Persian Gulf region. For decades, the Arabs had little control over the oil that lay buried in their soil. Others 'owned' and 'produced' and 'marketed' the oil, and gave the Arabs a generous pittance of their profits.

1. J R. Smith : Industrial and Commercial Geog, p 321.

Because of its importance in daily economic life and in war and national defense, oil became a significant factor in international politics and petroleum development and the control of reserves over the world became important security measures. Now the Arabs wish to establish their ownership of their largest and most valuable natural resource. They want to use oil to serve the interests of their own societies rather than those of the international oil tycoons. They want to be producers of their own oil, and to sell it to those who are ready to pay the best price. If these Arab intentions have alarmed some people and created a "geo political crisis", the fault is hardly with the Arabs. Times have changed, and with it the current of history.

The geo-strategy of oil has been for decades the monopoly of the tycoons, their modern conglomerates, the multinational corporations, and the governments that stand behind these powerful organised interests. Most of the western countries have used their ownership of Arab oil for blatantly political purposes. They have done this in Latin America and elsewhere. They still talk about defending their "strategic oil interests" in the Arab world with tanks, warships and jetplanes. The foreign oil interests operating in the Arab countries regard themselves as producers. Much of the present controversy, especially over Saudi Arabian oil, is about how many millions of barrels should be produced in the coming years. Arabian American Oil Company (Aramco) for instance, has been pressing the Saudi Arabian Government for a higher production schedule mainly because the United States has suddenly become dependent on Arab oil to the tune of 25% of its domestic requirements. Saudi Arabia, on the other hand, has to fix its production schedule largely from the viewpoint of its own, and of the Arab Community's interests.

ENERGY CRISIS IN WESTERN WORLD

The Americans and some of west European countries are facing an energy crisis for the first time in their history, their dependence on external oil is already 25 percent of their demand and is likely to rise to 50 percent by the end of this decade. They want the Arabs to increase production and guarantee that they will meet America's demands till such time as the United States has developed alternative sources of energy and can do without Arab oil. The Americans want the Arabs not to ask for unreasonably high prices, not to become producers of their own oil, and not to unite in order to protect their individual and collective interests.

The Arad stand on their own oil is primarily economic. The Arabs do not wish to lose their traditional customers. At the same time, they can not go on witnessing the spectacle that the United States armaments industries will run with Arab oil and supply more and more sophisticated weapons to Israel. The Arabs believe that the United States can rectify the impasse in west Asia by putting pressure on Israel to vacate the territories seized in the

wars of 1 67 and 1973 and conclude a peace based on justice and equality.

If the United States wants the Arab countries, particularly Saudi Arabia, to increase oil production in response to American and west European needs, there must be present in west Asia a suitable political atmosphere hitherto disturbed by the west Asian crisis and Zionist expansionist ambitions.

It is not that the Arab countries are in principle against increasing production. However, they must take into account three major factors in deciding their production. First, they must get a fair price for the most important natural resource determined by the cold logic of demand and supply.

Secondly, they must know how much of their revenue derived from oil they are able to use for the betterment of their individual Societies, for the Arab community as a whole, and for fruitful and constructive international collaboration.

Thirdly, oil being an exhaustible resource, they must take care to preserve the wealth for a long as they can.

ECONOMIC TIES BEHIND OIL

The main contradiction in the international oil scenario is that while the great bulk of the reserves lie in the Arab world, the industrialised nations outside the Socialist bloc, including the United States, can not do without Arab oil. The oil rich countries of west and North-west Asia stand in the following order of reserves :

Table 11·2

Crude oil Reserves, Continents and Major Countries, 1970*

(in millions of barrels)

Area	Amount	Percentage
North America	37,749	14
United States	31,613	12
Canada	3,678	1
Mexico	2,458	less than 1
South America	20,405	8
Venezuela	17,353	7
Colombia	625	—1
Asia	172,499	65
Kuwait	60,000	23
Saudi Arabia	51,000	19
Iraq	24,000	9
Iran	22,000	8
Indonesia	8,200	3

* U.N. Statistical Yearbook & International Yearbook 1974, etc.

Soviet Union	24,000	9
Europe	2,820	1
Romania	903	—1
Africa	8,374	3
Algeria	4,600	2
World	266,249	100

One is the desire to gain access to new markets for the kind of capital goods India wishes to export in increasing quantities. Another interest is in joint collaboration in developing mineral and other resources which are lacking in these countries. From both these angles, the states around the Gulf call it Persian or Arab-merit priority.

This is the context in which India is making its bid to establish mutually beneficial relations with oil-rich Gulf states. A beginning has already been made in Iraq by signing a contract for crude from a nationalised field now being developed with Soviet assistance. Plans for long range economic ties in other fields are being promoted separately. These developments can be interpreted to mean that India is cultivating Iraq to counter Iran's alignment with Pakistan in the favourable setting provided by the Baghdad–Moscow Treaty, but this is to assume that India is reconciled to playing a partisan role in the Gulf.

The littoral states–including non–Arab. Iran–are believed to have 62 percent of the known oil reserves of the world. As the reserves of other regions are depleted, as in the United States which has only 12 percent of the global reserves, the world will become increasingly dependent on the Gulf for oil.

By the end of the Seventies, the Arab States of the Gulf may have an annual income from oil of well over 40 billion dollars, or five times the 1970 figure with a present population of less than ten million. it is obvious that these countries will have huge surpluses of investible funds—so huge that spending on cadillacs and Swiss chalets will still leave a lot of money left over to make the oil rich countries a factor in the international money market.

Some of these countries—Kuwait for example—have already begun planning for the day when diminishing reserves may oblige them to cut down production. To make up for the consequent loss of revenue, they want to use their present wealth to build up diversified industrial assets at home and abroad.

These economic parameters readily explain the interest of the major powers in the region which is expressed in their readiness to sell arms to gain or consolidate influence. For example, Iran, the biggest oil producer and consequently the richest in the region. is getting Chieftains, the most powerful tanks in the world, from Britain, several squadrons of Phantom bombers and surface

to air missiles from the U.S., helicopters from the French, and anti-air craft guns from the Soviet Union.

The British, who moved into the gulf at the end of the 18th century to protect their lines of Communication with India, may have formally quit in 1971, but their interest in retaining a presence is clear enough from their involvement in military training in Oman and other states. In fact, the real power behind the throne in Oman is a British army officers.

The Americans entered into a naval agreement with Bahraein in 1972 to continue the use of facilities provided by the British before the island became independent. As neighbours correctly feared, this manifestation of U.S. military interest has had predictable repercussions. More important still, the Soviet Union is joined in a treaty relationship with Iraq since last April 1973, providing for coordination of their positions in the event of a development which "endangers the peace of either".

The Chinese are taking a hand too. They are said to be already training guerillas, which means that the Sultan of Oman is faced with a long-term problem of insurgency. The major problem in this decade is how to stabilise the strategic triangle (Triangular relations between America and Russia, Russia and China, China and America, in the face of China's nuclear ambitions. The U.S. and the Soviet Union admit that it is essential to control not only their own nuclear armaments race but also that of other potential nuclear powers. Most probably China is unwilling to accept any such control.

Pakistan is another country making serious efforts to expand its political influence in the area through loans of defence personal and offers of training facilities to meet both military and civil needs. Pakistan makes no secret of her interest in persuading the Gulf states, especially the smaller Sheikhdoms, to invest in Pakistan's development.

The geo-strategy of Gulf countries looked at from the viewpoint of oil supplies, the point to note is that the market situation puts the sellers at a considerable advantage. But they may still be interested in finding assured outlets for national crude as distinct from what the international companies produce. Most states in the region have already parcelled out promising areas but it may still be possible for India to join in bilateral or multi lateral prospecting efforts as it did in Iran.

Even outside the oil and petrochemicals field, there is substantial scope for trade and economic cooperation. Qatar, for example, imports fresh fruits and vegetables from as far as central America. There should be greater scope still for joinit ventures in oil processing industries which will give the hosts a change to benefit from the value added in the country. India's interest in setting up a plant to process the gas now flared in Qatar to produce ammonia for import into India. A similar offer to join hands in developing

petrochemical industries has been made to the United Arab Emirates.

In order to secure effective control of their most important treasure. some of the Arab countries—Algeria, Iraq and lately Libya—have nationalised all or a major portion of the foreign oil interests, with equitable compensation to the companies. Nationalisation must inevitably lead to Arab management of production and marketing—as has already happened in Algeria and very largely in Iraq, and as it must happen now in Libya. While the French have more or less gracefully reconciled themselves to the Algerian nationalisation, British and American interests have sought to raise a hue and cry about nationalization in Iraq and Libya. But the days when governments however powerful, could intervene to protect the oil interests of private companies are gone.

Oil crisis and New Techniques in industrial Revolution on Future Demands

In western Europe and the United States, various measures have been announced such as a ban on Sunday motoring, including the use of motorbikes, imposition of speed limits on cars (as a fuel economy measure), and the closure of petrol filling stations on Sundays.

In the United States, automobile manufactures have begun to cut back production of large high-fuel consumption cars while central heating thermostats have been turned down by approximately eight degrees.

In England, the British Government is backing a Cambridge University research unit to build houses that depend on renewable sources of energy such as the sun, wind and rain, and human, kitchen and garden waste (to generate gas for cooking and heating). Men are turning their minds to and basing their hopes, more than ever before. on the sun, the winds and the tides. A kind of new energy cult to exercise themselves of the oil genie is spurring scientific research and projects. The search is on for self heating houses from the sun, energy from the winds and tides which now goes unused, and the hidden riches still uncovered under the earth.

The oil genie has had both traumatic and encouraging effects. The people of the automobile era feel a sense of important and disorientation about their own standing in the world. They see Japan Kowhow and Great European nations make submissive gestures to 'petty' Sheikhs and "aline kings." On the Government level, the strongest manifestation is an almost unanimous warning that oil shortage and high prices will force them to reduce aid and investment to the rest of the developing world.

Petroleum development, on the other hand, served to raise living standards in developing countries Underdeveloped countries found to be oil producing were not the only one to benefit. Greatly increased and more readily accessible proved oil reserves stimulated

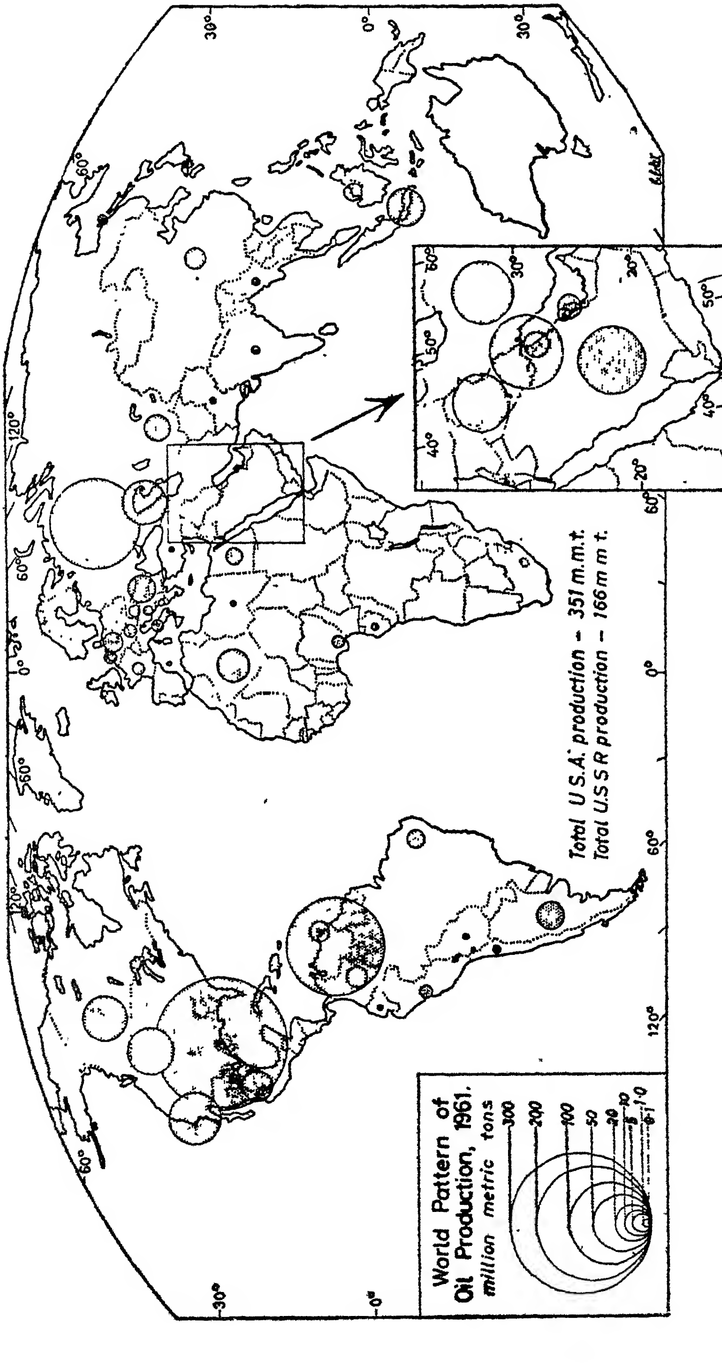


Fig. 11·9. World oil Production

the building of refineries in many countries. This greater availability to the energy resource, petroleum, promised to play a dynamic rôle in the improvement of living standards for all peoples.

The Soviet have done much work on coal gasification for industrial and domestic uses. In India, the only action so far taken on the energy crisis is to raise the prices of various petroleum products including, more especially, petrol, kerosene and cooking gas. This price rise is certainly a step towards curbing demand. Widespread preparations have been made in several countries to introduce petrol rationing if necessary.

The economic damage being caused by the oil shortage (the threatened fall off in production increased unemployment and lower standards of living) has reactivated some wartime practices. The good effect is that the trauma will now spur research and efforts to find new and more lasting sources of energy. And this could benefit the whole world in due course.

Production of Petroleum Resources

Though there are more than fifty countries of the world that produce crude oil; with an annual output of ubout 2000 million tons, over 90 percent, of the world's supply comes from four important regions. They are North Amercia, the Caribbean countries, the Middle East states and the U.S S.R. The Middle East is the leading producer, (more than 50 percent), followed by U.S.A. (12 percent), the U.S.S.R. (9 percent), Venezuela (8 percent) and North African countries (totalling more than 3 percent) Production of this fugitive fuel in many other parts of the world is rapidly increasing day by day. Table 11·3 gives the production figures of important countries of the world.

Table 11·3

Production Trends of Crude Petroleum*
in ten million tons

Country	1948	1960	1969	1973
U.S.A.	27·3	34·8	44·9	46·7
U.S S.R.	2·9	14·8	30·9	40·0
Saudi Arabia	1·9	6·2	14·8	28·6
Iran	2·5	5·2	16·9	24·9
Venezuela	7·0	14·9	18·9	16·8
Kuwait	0·6	8·2	12·9	15·1
Libya	N.A.	N.A.	14·9	10·7
Nigeria	N.A.	N.A..	2·6	9·1
Canada	0·2	2·6	5·5	7·3

*U.N. Statistical year book; 1973 & the International year book 1974 etc. N.A =Not available.

Iraq	0·3	4·8	7·4	7·1
Indonesia	0·4	0·2	3·9	5·4
Algeria	N.A.	N.A	4·4	5·0
Neutral Zone	N.A.	0·7	2·4	3·3
Trucial Oman	N.A.	N.A.	2·9	2·9
China	N.A.	N.A.	N.A.	2·3
Qatar	N·A.	0·8	1·7	2·3
Mexico	0·8	1·4	2·1	2·2
Argentina	0·3	0·9	1·9	2·2
Muscat & Oman	N.A.	N.A.	1·6	1·7
Australia	N.A.	N.A.	N.A	1·6
Rumania	0·4	1·2	1·3	1·4
Colombia	0·3	0·8	1·0	1·1
Bulgaria	N.A.	N.A.	N.A.	0 3
Hungary	N.A.	N.A.	N.A.	0·1
Poland	N.A.	N.A.	N.A.	0·3

At the end of 1971 the United States had 517,318 oil wells in actual production. The following are the cheif oil states and the number of wells in production in each.

Table 11 4

Number of wells in U. S. A.

(Daily Production in barrels)

States	Nos. of wells	Average daily Production per well
Texas	17,696	19·2
Louisiana	26,829	93·6
California	39,668	24·5
Oklahoma	75,572	7·6
Wyoming	8,952	44·5
Kansas	42,180	5 0
New Mexico	17,210	18·0

The average over all production per well per day in 1971 was 18·1 barrels, but this varied greatly in the different producing states ; Alaska, for example, with only 173 producing wells produced an average of 1,161·8 barrels per well per day while Pennsylvania with 34,029 wells produced 0·3 barrels per day.

NATURAL GAS

Natural gas is also the cheapest source of energy, and is generally but not always associated with petroleum. Surface

seepages are often found, gaseous, liquid or solid ; but less reliance is placed on these now than heretofore. Natural gas (methane) hydrogen sulphide (H_2S), and Carbon dioxide are the commonest gases. It is used in many purposes. At Heathfield, Sussex, natural gas was used to light the railway station for many years. It is widely used for house heating, cooking, water heating, and production of electricity etc.

The United States is the largest consumer of natural gas. During the last decade, natural gas production has nearly doubled and reached a record figure of 89,060 billion cubic metres in 1970. Practically the whole of this 40% comes from the United States, followed by the U. S. S. R. and Canada. The major natural gas provinces in the U. S. A. are Anadarko basin, McAlester Basin, Denver Julesburg Area, Green river basin, Appalachian basin, Permian basin etc. The Soviet Union accounts for about 15 percent of world natural gas production and has more than 20% of world reserves. The Soviet Union is the world's second largest producer of natural gas ; only the U. S. A. surpassed it. The U. S. S. R. possesses enormous reserves of natural gases occurring both in combination with oil and separately. Gas pipelines from Bugurustan to Kuibyshev, from Saratov to Moscow and from Dashava to Kiev have already been laid.

The production of gas in U. S. S. R. rose from 4530 billion cu. m. in 1960 to 19,621 b. cu. m. in 1970. In the 1956—1966 period the production of gas was increased approximately by 290 percent. Fig. 11·10 shows the natural gas fields of the world. Digits are given on map as follows—

1. Appalachin Basin
2. McAlester Basin
3. Anadarko Basin
4. Denver Julesburg
5. San Juan Basin
6. California Area
7. Pérmian Basin
8. Gulf Embayment
9. Wilhiston Basin
10. Pincher Creek
11. Ploesti.
12. Transylvanian Area
13. North Italy
14. Grozny-Tbilisi Area
15. Stavropol
16. Kharkov
17. Orel Bryansk
18. Minsk-Kiev region
19. Puerto Cabello
20. Comodoro Rivadavia
21. Pemex
22. Poza Rica
23. Groningen
24. Zelten
25. Sui
26. Tzekung
27. Sylhet
28. Uttaran
29. Hassi R'Mel
30. Kariba.

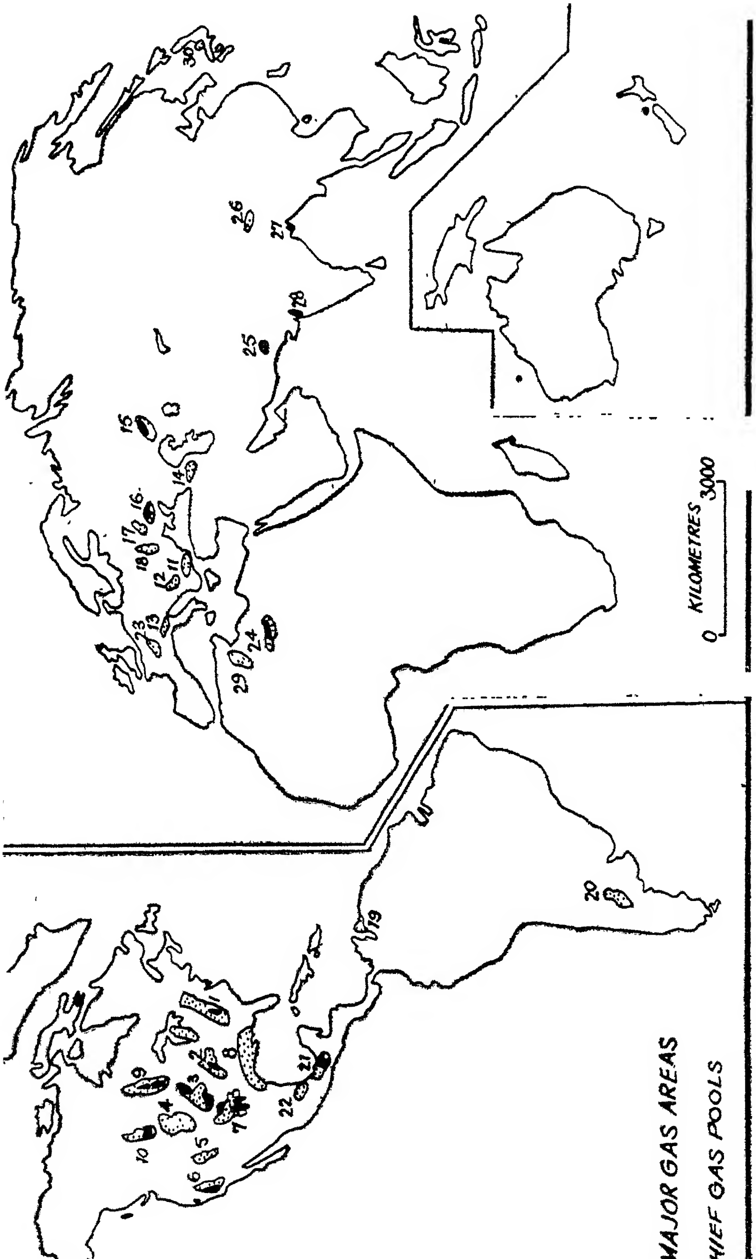


Fig. 11·10. Distribution of Major Natural gas fields of the world.

Table 11·5 shows the production of Natural gas in various countries.

Table 11·5
Production of Natural Gas*
Figures in ten million Cubic metres

Country	1960	1970
U.S A.	36,164	62,100
U.S.S.R.	4,530	19,621
Canada	1,481	6,616
W. Germany	92	2,547
Rumania	1,014	2,510
Netherland	36	2,185
Mexico	967	1,865
Italy	645	1,313
Iran	95	951
Venezuela	461	857
France	284	696
Argentina	138	546
Poland	N.A.	514
Indonesia	N.A.	428
U.K.	N.A.	393
Hungary	34	342
Kuwait	94	325
Algeria	0·7	299
Japan	82	270
Chile	89	227
Pakistan	63	223
Austria	147	187
Afghanistan	N.A.	160
Colombia	40	140
Libya	53	125
World	**46,840**	**89,060**

U.N.O. Production Year Book, and The International Year Book 1974.

CHAPTER 12

WATER POWER

Coal, lignite and oil reserves are subject to depletion and exhaustion, water power resources are comparatively permanent, although they can be diminished by poor land-use practices leading to irregular flow, silting of reservoirs, etc., fuelwood reserves can be renewed and increased, and coal reserves, though they can be exhausted, are supplemented by the use of water power.

It seems clear that coal and lignite, which are the principal sources of industrial power today, will continue to be the principal source as long as the technological basis of industry is not fundamentally altered. Although the reserves of these minerals do not seem likely to be exhausted in the near future, the growth of population will shorten their lifetime and accelerate the increase of costs in the long run. Fig. 12·1 shows the major power belts of the world.

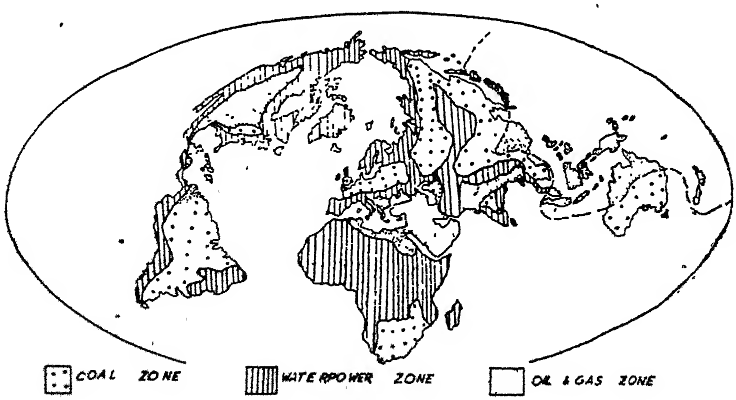


Fig 12·1. Power Zones of the world

The Significance of Water Power

Cheap electric power is essential for the economic development of a country. In fact modern life depends so largely on the use of electricity that the quantity of electricity used per capita in a country is an index of its material development and of the standard

of living attained in it. Apart from its use in industrial undertakings, electricity has a remarkable diversity of application.

Electricity can provide cheap power for pumping water for irrigation and for numerous operations in agriculture and also in the home. Extensive use ot electricity can bring about the much needed change in rural life of developing countries especially in India, and Asio-African countries of the world. There are many industrial areas where the need for more electricity is immediate. In these areas, the growth of water power has not been able to keep pace with the growth of population.

It can not only improve methods of production in agriculture and encourage cottage and small scale industries but can also make life in rural areas much more attractive, and help in arresting the influx of rural population into cities.

Water-power and Natural Environment

From the standpoint of the natural environment, water-power depends upon steep gradient, huge volume of water, and regularity of flow. Fortunately these conditions occur widely over the earth, especially in mountains and hill country. None of the world's rivers has a perfectly uniform stream-flow season by season and year by year, not most rivers are not ideal. Monsoon lands of South eastern Asia receive their rain in summer, and in winter rivers run dry, while in Mediterranean lands opposite conditions prevail. Even the mighty Sone, flowing through rain-drenched jungle, has its flood seasons. Because of seasonal and annual variations in stream-flow, dams and reservoirs are often needed to store water. The character of precipitation is often as important as its volume. The lofty Himalayas get most of their moisture as winter snow. It takes time for snow to melt, some water soaks slowly into the ground and reappears gradually in springs and mountain streams.

In case of India two physical features of the country the predominance of mountain land and the abundance of precipitation, are responsible for large potential water-power. The volumes of flow of the short but vigorous Deccan rivers varies considerably, periodically with the seasons and non-periodically with spells of drought and extreme rainfall, for the country as a whole. Mid-June, to September, are the months of maximum flow and available water power. February to May are the periods of greatest deficiency. To provide for effective use of water power resources in the face of the variable stream flow, a number of regulating ponds (especially in Maharashtra) and reservoirs have been established after independence all over India.

World's natural water power generating stations are more or less evenly distributed over the face of the earth. Decentralization of power plants is, therefore, a natural result.

THE GEOGRAPHICAL DISTRIBUTION OF WATER POWER

In the hilly, mountainous areas and in those parts of plateaux which are far away from coal, and where waterfalls are numerous, hydro-electricity is being developed where there is demand for it. The pattern of water power distribution of the world reflects chiefly the terrain conditions and the amount of precipitation. Where the land is elevated and the precipitation heavy the potential water power is great. Africa is not the largest or the most mountainous continent, but it contains the largest area of high land within the zone of heavy Tropical rainfall, and hence the great African rivers, especially the might Congo, offer the world's greatest supply of water power.

The capacity of electric power plants in the United States in 1970 was 209,774,000 kilowatts. The capacity in the Soviet Union was 82,600,000 kilowatts, in the British Isles 42,242,000 in west Germany 31,826,000 in Japan 29,142,000 and in India 14,709,000 kilowatts. The United States, Canada and western Europe now lead in water power generation, producing about two-thirds of the world electric power. Other important producing countries include Canada, France, Italy, Sweden and China Mainland. Comparing the position of India with some of the countries of the west, it is clear that the development of hydro-electricity here is insignificant. The ratio between the total water power developed in varions countries to their potential estimates of water power is given in table 12·1. Fig. 12 2 shows the potential and developed water power of the world.

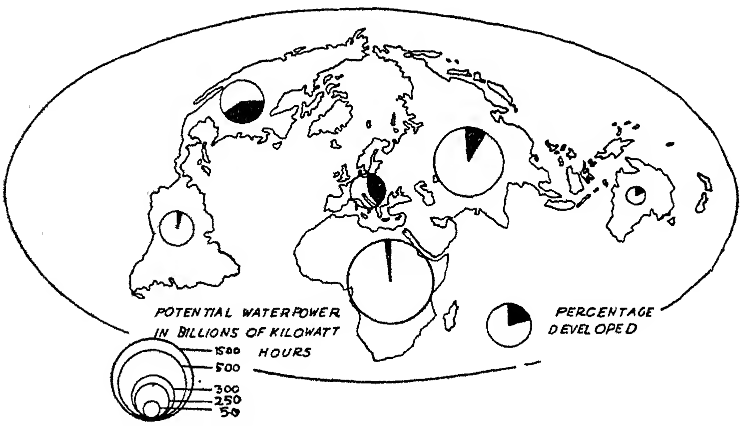


Fig. 12·2. Potential and developed hydro-power of the world.

Table 12·1

Countries Potential water power and percentage of their total developed water power.[1]

Country	Potential water power (in millions of horse power)	Developed water power (Percentage to potential)
U.S.S.R.	78·0	34%
Southern Asia	40·0	2%
U.S.A.	148·0	25%
Canada	N.A.	34%
China	22·0	12%
Brazil	16·0	3%
Norway	10·0	89%
Switzerland	4·0	54%
France	6·0	71%
Italy	6·0	54%
Japan	7·2	62%
Germany	4·0	54%
India	14·0	2%

POWER DEVELOPMENT IN BOTH THE AMERICAS

The total hydroelectric power resources of the United States, both developed and undeveloped, were estimated to be approximately 209,774,000 kilowatts. The first hydro-electric scheme undertaken in U.S.A. was that of Grand Coulee and Hoover Dams. Grand Coulee Dam is the largest concrete dam in the world and its construction had to wait until technology and capital were adequate to erect a dam 165 m. high above bed rock, 150 m. thick at the base, and 1290 metres long. Many great dams are constructed in arid and semiarid lands for other purposes besides that of additional water supply for farms and urban centres. Water power encourages dam building as much as irrigation in many cases, for example, at the Grand Coulee and Hoover dams; so does flood control, as exemplified by the Tennessee valley and Missouri valley projects, and navigation also may be an additional purpose for dam building besides irrigation, hydroelectric power, and flood control.

Government's huge Hanford plutonium works also situated in Columbia valley. Hanford consumes large amounts of electricity,

1. Various sources—Developed and Potential water power of the United States and other countries of the world, science 119 : 329. Production year books, United Nations and Statistical year book, FAO publications and Developed and Potential water power of the world. Percentage is calculated by the author.

and it is therefore strategically located on the Columbia (near Pasco) between Bonneville and Grand Coulee, but closer to the latters greater capacity. The Hanford works also require vast amounts of cooling water, so that location on a large stream is necessary. The Columbia, with its cold water and enormous minimum flow regulated by Grand Coulee Dam, is not deeply intrenched at this point, so that water can be easily taken.

On the river Niagara near Niagara falls plants were established by Canadian and U.S.A. joint enterprize. In 1954 ground was broken for the first phase of the $ 600 million joint Canadian U.S. St. Lowrence Power enterprise. The Niagara falls are divided by Goat Island into the American Fall and the Horseshoe Fall. The American Fall, Goat Island, and half the Horseshoe fall belong to the United States, and the other half of the Horseshoe fall to Canada.

Of all the projects the Tennessee valley Authority is the most ambitious in outlook. For it aims not only as developing power, but also providing irrigation, controlling floods and malaria, introducing scientific management of land, promoting actively the economic development of the enture basin and improving navigability of the Tennessee river. By 1963 after the TVA had been in operation for thirty years the twenty first dam, the Melton Hill, was nearing completion. The authority controlled a total of 32 reservoirs and virtually regulated the flow of the Tennessee river. It has a powerhouse with a capacity of 12,711,000 kilowatts. Dams have been constructed at many points on the Columbia river and six of the world's greatest power developments on it—Grand Coulee, Bonneville, John Day, Chief Joseph, The Dalls and McNary—all completed.

A number of major and minor power generating stations have also been completed or are nearing completion in the U S.A. The most important are : Hoover Dam (1318 kwh.), The Robert Moses Niagara Power Plant (150,000 kwh.), Priest Rapids and Wanapum (500,000 kwh.), Glen Canyon (910,000 kwh), Flaming Gorge (108,000 kwh.), Davis Dam (225,000 kwh.), Fort Randall Dam (320,000 kwh.), Lawrence Power Plant (450,000 kwh.), Parker Dam (120,000 kwh.), Roosevelt Dam, Fremount Canyon Dam, Garrison Dam, Gavine Point, Hungry Horse Dam, Long Sault Dam, Melton Hill Dam, Oahe Dam etc.

The hydroelectric potential of Canada may be measured by the amount of snowfall and the average elevation, the former reflects the value of the rivers and the latter their gradients. Thus, there are four important hydroelectric producing centres in Canada :

1. **South-western Canada**—Region of heavy rainfall and one-thirds of the Canada potential water power is estimated in this region.

2. **Eastern Canada and North eastern U.S.A.**—Erom the standpoint of development, the St. Lawrence area of Quebec and

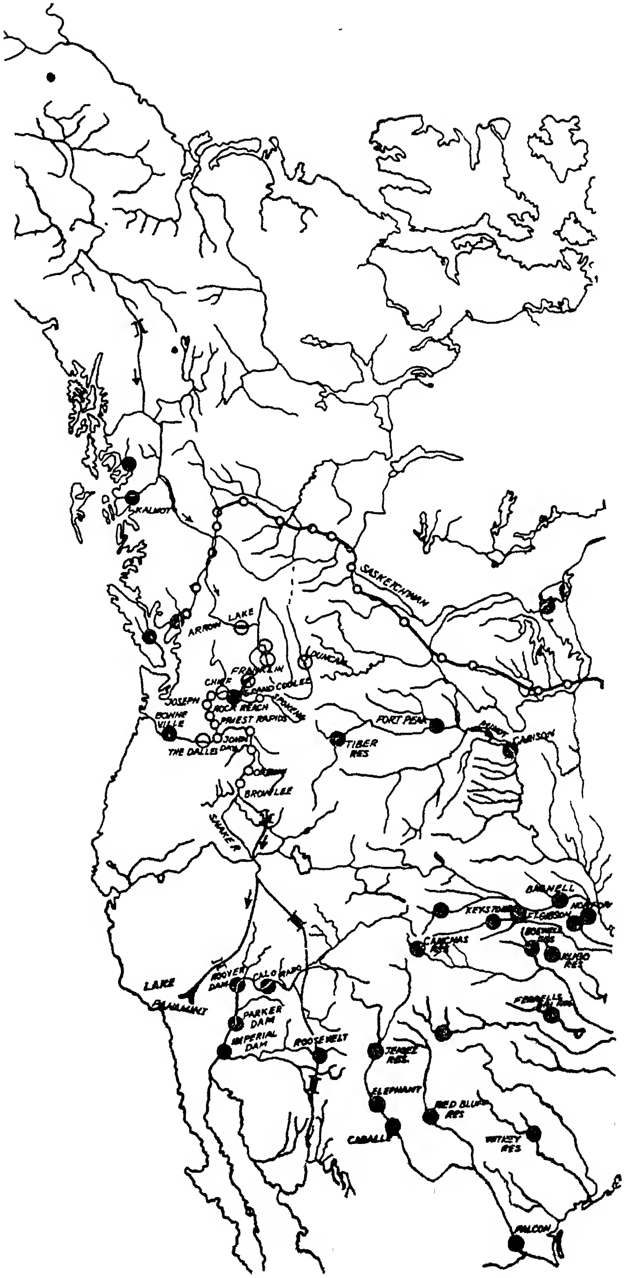
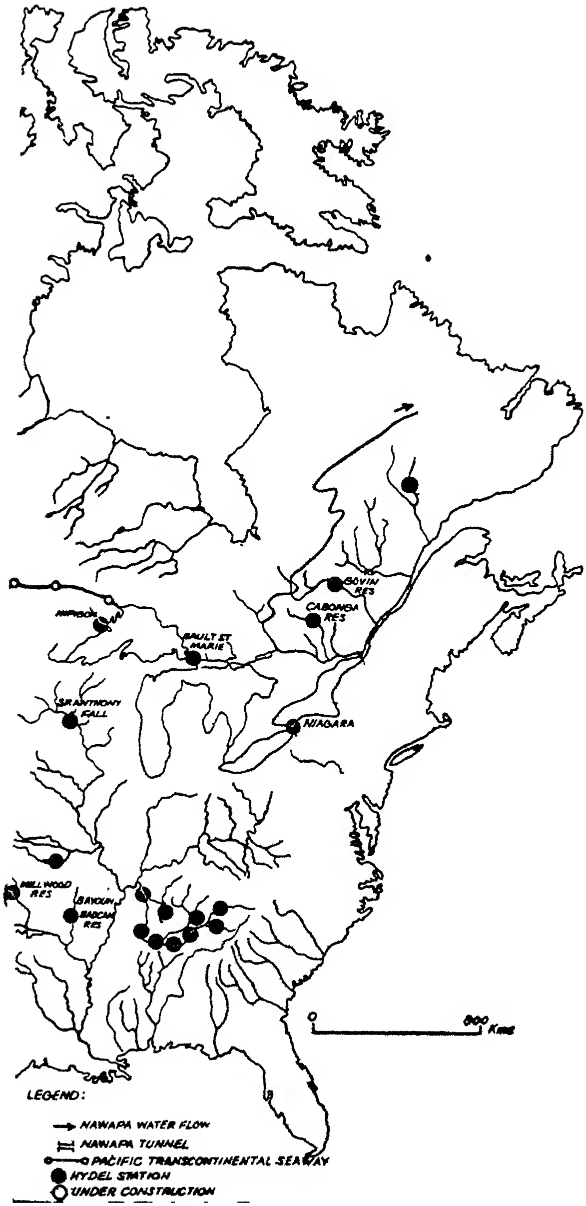


Fig. 12·3. Hydro-electric Plants of



North America.

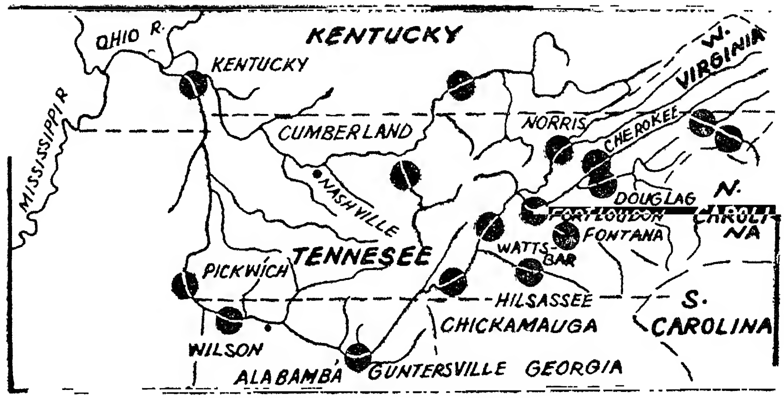


Fig 12 4. T V.A. of North America

Ontario leads, with 80 percent of the total—the result of numerous lake-fed streams with many falls and proximity to Canada's portion of the American manufacturing region.

3. The Great Lakes and Winnipeg region--Dams have been constructed on Albany, Saskatchewan and Nelson rivers north of Canadian National Railway.

4. North western Region—innumerable lakes and rivers and much rugged terrain is well endowed with potential hydropower.

POWER DEVELOPMENT IN EUROPE

In Europe, the rivers of Norway and Sweden has already been utilized for the generating of electricity. Norway has developed more of its potential power than has any nation on the earth. Norway, Sweden, Italy and Switzerland together possess about one-half of the developed horsepower of Europe. The mountainous nature of these countries, along with its heavy precipitation and snowfall, gives the area a large hydroelectric potential. Unlike most other parts of the continent, these countries are deficient in coal, petroleum and natural gas. Norway leading the whole world in water-power development per capita. Table 12·2 shows the average per capita production of water-power.

Table 12·4

Per capita Production of water power[1]

Norway	9000 Kwh.
Canada	7000 „
Sweden	6434 „
U.S.A.	6550 „
U.K.	3481 „
Japan	1115 „
India	71 „

1. Statesman year book and Electrical world 151, 49–50.

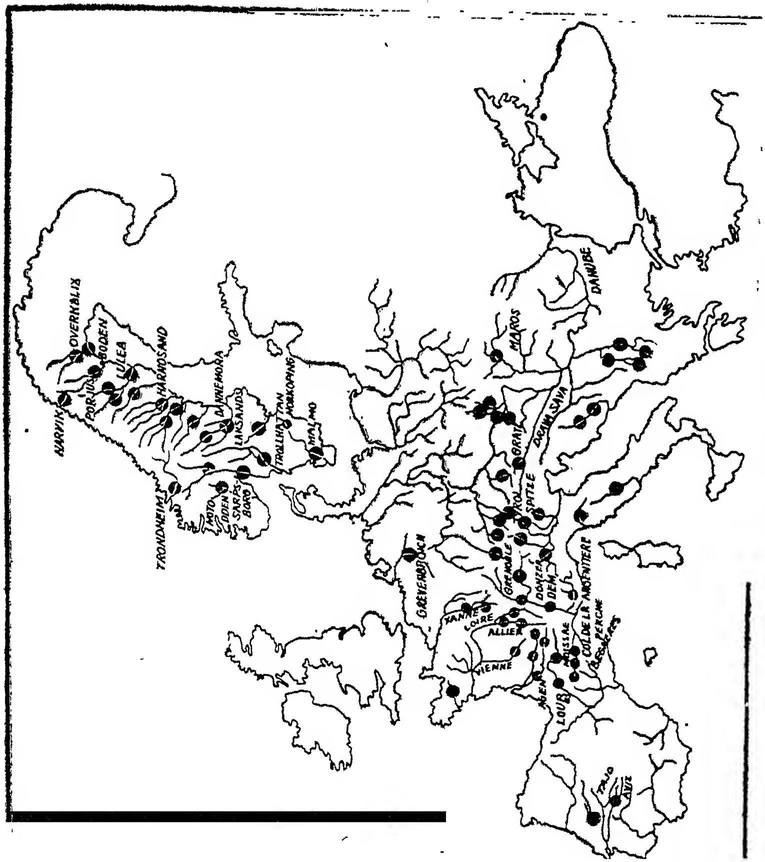


Fig. 12.5. Hydro-electric Plants of Europe

Norway is watered by Glomma, Gudbransdal, Numedal etc. The important power generating stations are situated on Gudbransdal, Numedal, Odda etc. at Lillehamber (20,000 kwh.), Nore (100,000 kwh), Rjukan (250,000 kwh.) Skien (2000 kwh.), Arendal (20,000 kwh.), Odda or Tysse (100,000 kwh) and Saetersdal valley project (60,000 kwh) etc.

The most important hydro-electric works connected with irrigation works are those of Rhone-Sone valley project. The power is generated from several places. The power stations are situated at Lyons (3000 kwh.), Valence (400 kwh.), Grenoble (500 kwh.), Donzere (300-400 kwh), Mondragon (400 kwh), Orange (500kwh.), Arles (400 kwh.) etc.—all are in Rhone-Sone valley of France. The generating works have been continuously extended. The average production of electricity in comparison with some of the other countries is given in the following table :[2]

Table 12·5

Production of Electricity in Europe (000 million kwh.)

Austria	12 0
Finland	7·7
France	38·2
Italy	48·4
E. Germany	0·7
Norway	33·6
Spain	15·9
Sweden	36·6
Switzerland	22·2
W. Germany	12·9

POWER DEVELOPMENT IN ASIA

The total hydro-electric power resources of the Soviet Union, both developed and undeveloped, were estimated to be over 82,600,000 horsepower and only 4300,000 horsepower were developed. Over 83,000,000 horsepower remain to be developed in the future. The major Hydro-electric works are described in the following description :

1. Dnieper valley Project—In Ukraine there are two great hydro-electric works. The first, Dnieprozhaz is situated on the great band of Dnieper river, where water is stored up in big reservoiers and ~~power transmitted~~ to Kherson over a distance of about 200 kilometres by overhead ~~wires. (2) Zaporozhe is second important~~ power generating station in Dnieper valley project. Dnieper valley project is a household word in black earth of Russia, because it has brought prosperity to a large part of the Ukraine region. These hydro-electric schemes have a combined normal capacity of 1,000,000

6. Developed and Potential water power of the world, Europa year book 1972 Statistical year book, Production year books-UNO.

h.p. and provide electricity for the city of Odessa and its suburbs, Nikolaev, Dnepropetrovsk etc.

2. **Don Valley Project**—A power-house containing four units with a capacity of producing 130,000 kilowatts have already been completed. Power is being supplied to Rostov and Stalino and other cities. The power house is situated at Shimlyansk.

3. **Leningrad Project**—This project envisages a dam across the Volkhov and second Svir Rivers near Leningrad. This project serves Kalimin, Novgorod and Pskov region. A hydro-electric station constructed below the dam on Leningrad side also, with three generator units of 5000 kw.

4. **The Volga Valley Project**—In Soviet Union it is the first of a chain of dams planned for harnessing the waters of Volga. Dams have been constructed at many points on the Volga river and on Astrakhan near Caspian Sea. Molotov Gorki, on Volga, the first dam has been constructed. A power-house containing 6 units with the capacity of producing 2 million kilowatts, equal to that at Grand Coulee in the United States.

The second dam on this river is situated at Yurolloevs and the third at Kuibyshev and fourth at Stalingrad. The plant at Kuibyshev is believed to be the largest of the Volga group, with a capacity of 44 million kilowatts.

The three power houses at Stalingrad, Saratov and Chevokesari have combined installed capacity of 88 million kilowatts and a total firm capacity of 44 million kilowatts.

The western part of Russia, in the basins of the Volga and Terek rivers, has termendous resources of fresh water which are being used to a very insignificant extent within the desert zone. The main water uses in that part of the zone are power generation (Volgograd hydro plant), shipping, and fisheries. Agriculture uses a relatively small amount of water, mainly for flooding floodplain lands and limans or (irrigation basins), although it does effect the timing and amount of water released from the reservoirs of the Volga river for this purpose. Fig. 12·6 shows the Hydro-electric Plants of Russia.

The construction of Ural-Kushum watering and irrigation system now being completed on the Ural river is supposed to provide 9,000 hectares with regular irrigation and about 50,000 hectares with basin irrigation and to water about 1 million hec. of range lands. Further irrigation and range watering in this region will require the diversion of Volga water through the proposed Volga-Ural canal starting at the Volgograd dam.

5. **South Surkhan Irrigation and power project**—This project is situated in the lower reaches of the Surkhan Darya, which enters the Amu-Darya at Termez in the Uzbek S.S R. on the border of Afghanistan. An earth dam, 32 metres high, was built on the Surkhan-Darya in 1960-62, and the reservoir with a expected

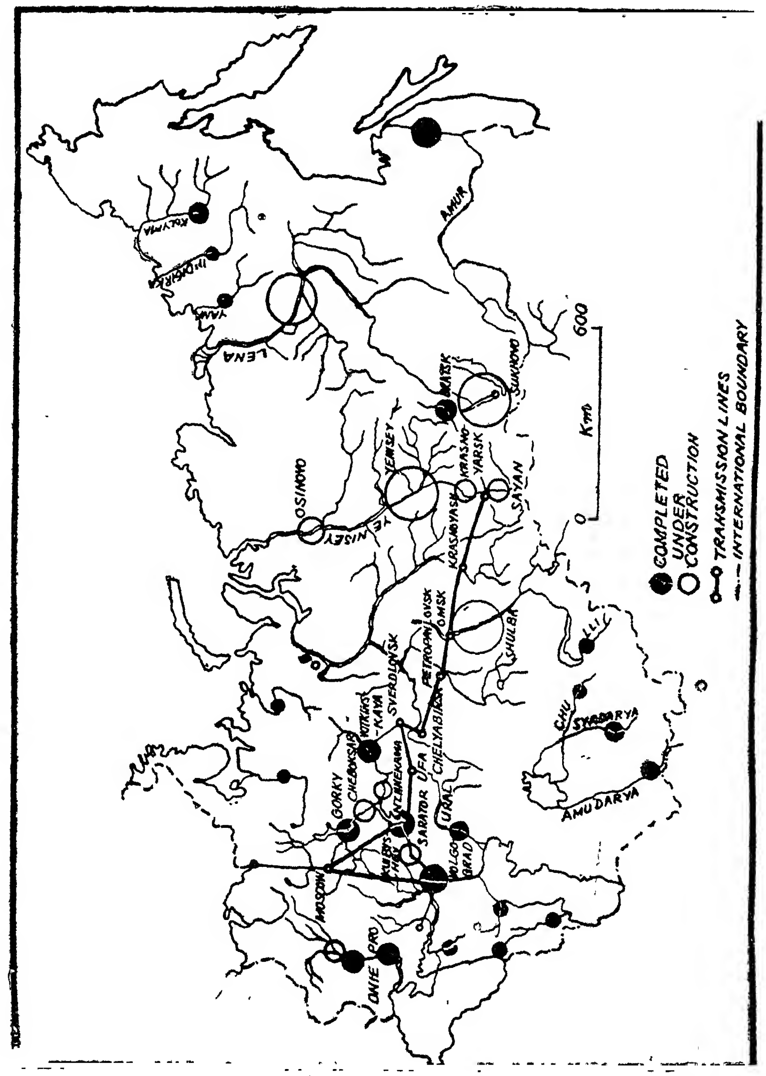


Fig. 12·6. Hydro-electric Plants of Russia.

capacity of 800 million cubic metres. This project is producing now about 2000 kw.

6. **The Expension of Amu-Bukhara Project**—The project is designed to improve the water supply and electricity of the Bukhara oasis, which in the past has been dependent on the irregular flow of the Zeravshan river. It can deliver 60 cubic metres a second to the Kuyu-Mazar reservoirs for use in the Bukhara oasis. The first stage improves the water supply on about 100,000 hectares of cotton lands in the Bukhara oasis. It is proposed to increase the capacity of Amu-Bukhara project power station by 210,000 kilowatts.

7. **Tke Angara Valley Project**—The hydro-electric installations at the various dams and the Brashak Yenisei power station of the Angaro valley scheme has linked by many transmission lines. Two hydrel power stations were built at Brashak Yenisei and at Krashnoyask. This power generated from the Angara valley project is used in running saw mills, paper and pulp factories and flour mills in Siaberia. It is proposed to increase the capacity of Angara valley project by 6200000 kilowatts. It also supplies energy to metal works at Kyakhta, mica mining at Zima, lead smelting at Ulan-Ude and oil, coal and saw factories of Irkutsk and to many other industrial concerns, both big and small.

. Now reservoirs have been built on many streams and tributaries, including the Syr-Darya, the Zeravshan, the Kashka Darya, the Surkhan Darya, the Angren, the Tedzhen, the Chu, the Arys, the Kassan-Say, the Kara-Ungur, the Yakh-Su, the Isfayram-Say, the Katta-Say, and the Guzar. In addition, large reservoirs have been built on the Vakhsh, the Naryn, the Kara-Darya, the Chirchik, and the Ili.

HYDRO-ELECTRIC DEVELOPMENT IN FAR EAST

Hydro-electric potentials of China have been estimated at 22,000,000 kilowatts, but development is largely for the future. As far future possibilities, Szechwan, Yunnan and Sikang lead with 6,210,000 ; 6,016,000 and 3,529,000 potential horsepower, respectively, largely along the Upper Yangtze. Dams were built at the Hukow falls on the HwangHo and in the Yangtze Gorges, with a capacity of 4,000,000 horsepower.

Large reservoirs and installations have been developed at the Hisaofengman dam on the Upper Sungari river and at Supung on the Yalu river: The total electric capacity is listed as about 4,000,000 kilowatts. Fig. 12·7 shows the Hydro-electric Plants of Far East.

Japan is a important country of Asia. Heavy rainfall, rough topography to cause water to fall, and a regular and continuous flow of water are the three important geographical requirements for developing hydro-electricity. Of these the first two are found over a large part of Japan, but as regards third, Japn is unfavourably situated. The seasonal distribution of rain and its precariousness tend to make the flow of water in streams very irregular.

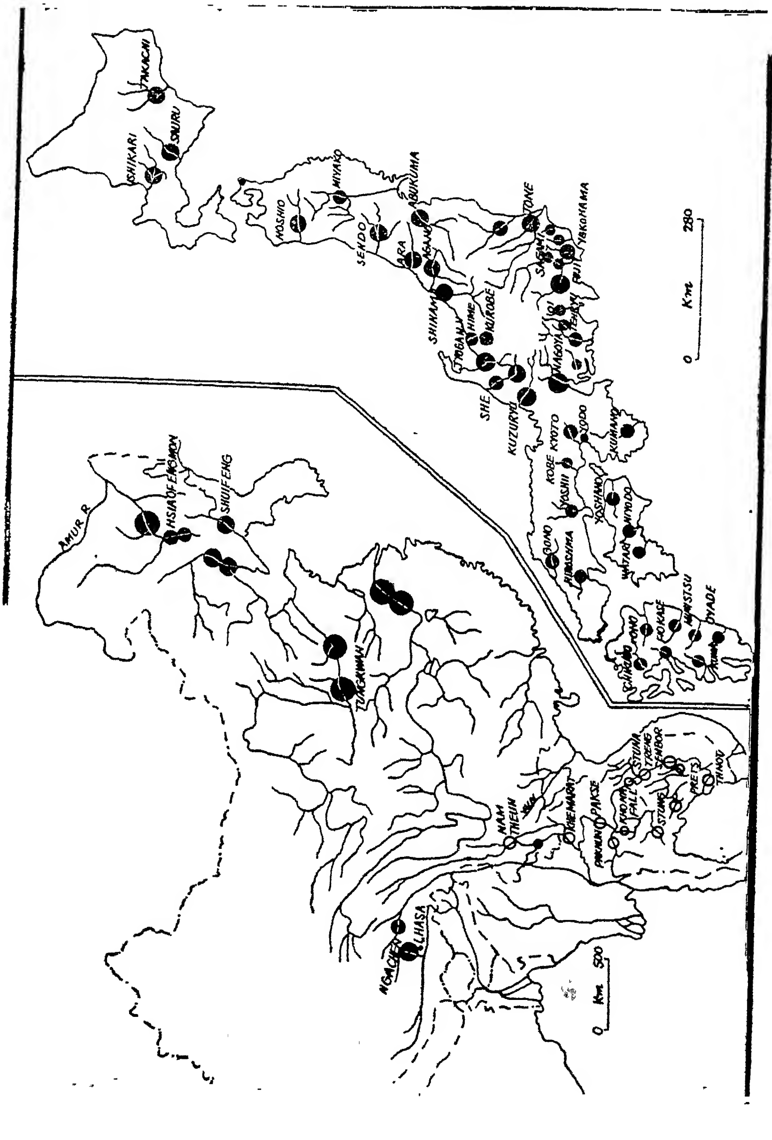


Fig. 12·7. Hydro-electric plants of Far East.

This necessitates making of high masonry dams to create artificial lakes to feed the power-house regularly. The characteristic river of Japan has a small drainage basin and small volume, and is short and swift. Decentralization of power-houses or plants is, therefore a natural result. The large number of hydro-electric plants are concentrated in the central part of Honsuh, the broadest and most mountainous section of Japan, where rivers are comparatively long and have the greatest volume and velocity. This region of maximum hydro-electric generation and consumption is in relatively close proximity to the four greatest industrial region of the country—Tokyo-Yokohama ; Osaka-Kobe-Kyuto ; Nagoya and north Kyushu region.

Dams were constructed at many places on Shinamo, Kiso, Tone and Fuji rivers. There were about 90 plants on the Shinano river alone, over 80 plants in the Kiso, 70 on the Tone and over 50 on the Fuji river. There are over one thousand hydro-electric plants in Japan and producing over 9,000,000 horsepower per year.

POWER DEVELOPMENT IN INDIA

Irrigation and power have been among the most significant fields of development in India since the beginning of the First Plan. The development of power is a pre-requisite for carrying out large industrial programmes. River valley projects like Bhakra-Nangal, Hirakud, Chambal, Tungabhadra, Nagarjunasagar, Koyna, Kosi, Rihand, Ramganga hydro-electric project, Idikki, Gandak, Mettur, Periyar, Machkund, and the D.V.C.. which provide both irrigation and power, have, along with other programmes of development a leading role in establishing higher levels of well being in the regions served by them.

The total installed generating eapacity in India at the beginning of the First Plan stood at 2·30 million kw–0·63 million kw in state owned public utilities, 1·08 million kw in company-owned public utilities and 0·59 million kw in industrial establishments having their own power stations. During the First Plan, the aggregate installed generating capacity increased by about 49 percent, the actual addition being 1·12 million kw, as against the target of 1·40 million kw. During the Second Plan, generating capacity increased by about 67% from 3·42 million kw to 5 70 million kw. As against the initial target of 3·48 million kw., the actual addition was 2·28 million kw. To avoid conditions of severe power shortage in the early years of the Third Plan, steps were taken to provide foreign exchange for implementing the remaining power schemes of the Second Plan, which had earlier been classified as 'non-core' projects. Work was also taken up on a few additional power schemes which were not originally included in the Second Plan. The additional generating capacity installed during the Second plan averaged about 0·45 million kw per annum. While it is proposed to step up this programme by commissioning 1·4 million kw per year on an average during the Third Plan, the pace of development in the Fourth and

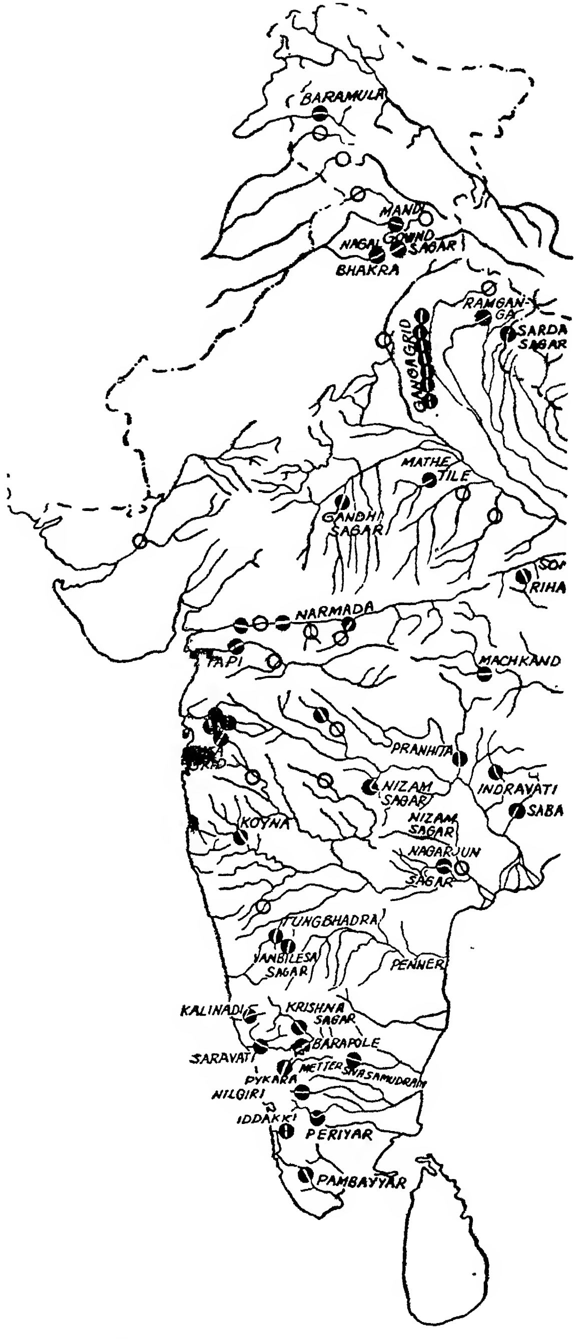
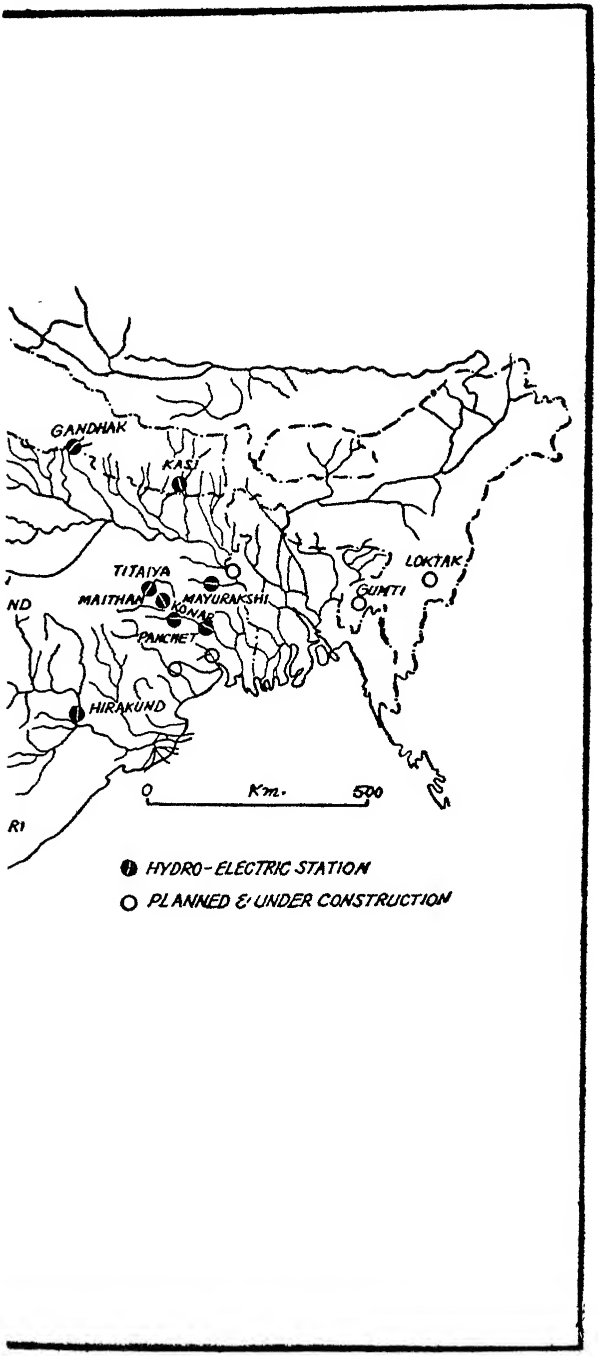


Fig. 12 8. Hydro-electric Plants


GANDHAK
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of India.

subsequent Plans would be higher. Thus, by 1975–76, the aggregate installed generating capacity in the country may be of the order of 35 million kw. According to present estimates, roughly fifty percent of this capacity could be provided from hydro-electric projects (as shown in Fig 12·8) and the balance mainly from thermal stations. The growth of steam, diesel, Hydro and nuclear plant capacity during the period was 146,124 and 451 percent respectively. The progress of electricity supply in India during 1968 to 1974 in actual figures is shown is table 12·4.

Table 12·4

Progress of Electricity Supply in India.

Year	Installed Plant Capacity 000 kwh.	Electricity generated by public utilities (Million Kwh)					
		Steam Plant	Gas Plant	Oil Plant	Hydro Plant	Nuclear Plant	Total
1968	11,884	1,928	9	18	1,696	85	3650
1969	12,957	2,201	14	14	1,830	182	4123
1970	14,102	2,304	16	9	2,069	150	4576
1971	14,709	2,579	18	9	2,155	150	4910
1972	15,254	2,954	20	8	2,305	170	4000
1973	16,228	2,874	30	9	2,170	172	5527
1974	—	—	—	—	2,461	—	4685

In India the commercial energy demand is mainly supplied by electricity 52 percent follwed by coal (43 percent) and oil 5 percent only.

Production of Hydro Electricity

Of the total estimated hydro electric power potential of the world, only a fifth is developed, mainly in the temperate lands of America and Eurasia each of which accounts for almost 40 percent of the worlds developed hydro-electric power although they have together less than 15 percent of the world's total water power potential.

In terms of hydro-electric power production the U.S.A. leads, according to available data for about 23 percent, followed by U.S.S.R., Japan, Italy, France etc. Table 12·5 shows the hydro and thermal power production for selected countries.

Table 12·5

Hydro-electric Power Production*

Country	(Figures in million Kwh) Total Electricity output	Hydro-electric	Nuclear
U.S.A.	1,316,614	224,894	7,655
U.S.S.R.	587,699	88,571	N.A.

*U.N. Statistical year book and International year book 1974.

Japan	244,863	69,655	629
U.K.	209,368	5,741	24,231
West Germany	180,712	16,544	1,225
Canada	165,625	132,748	143
France	111,637	45,134	2076
Italy	96,829	42,949	3152
East Germany	56,686	1,090	N.A.
Sweden	53,796	49,275	50
Norway	52.814	52,721	N.A.
Spain	41,200	22,733	N.A.
Switzerland	30,533	29,730	N.A.
Netherlands	30,056	N.A.	N.A
Brazil	32,654	27,905	N.A.
World	3,843,600	——	N.A.

Electric power can be obtained from variety of sources other than hydrel and thermal generators. Other sources of power are nuclear and solar energy. As a result of the greatly increased demand for electricity all over the world, both thermal and hydro-

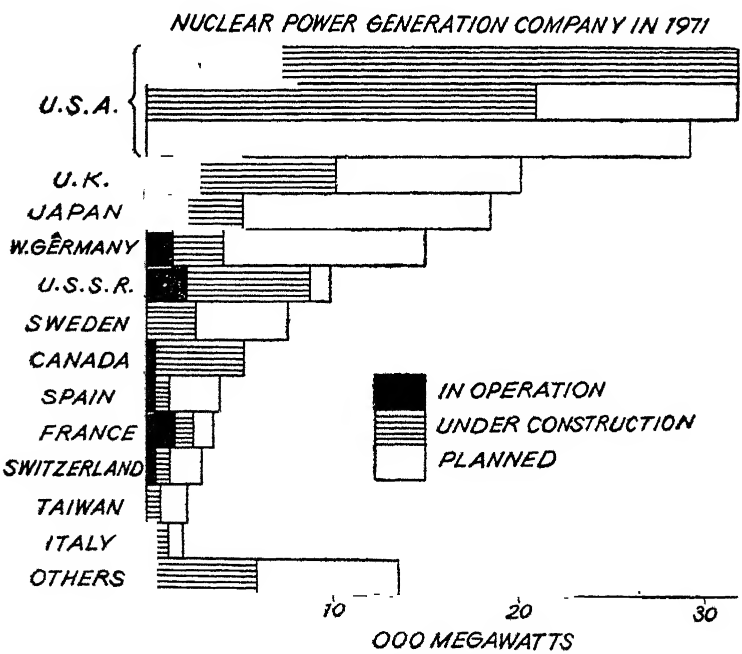

Fig. 12·9. Nuclear Power Generation Capacity of selected countries

electric plants have multiplied rapidly in recent years. Thermal power development is generally based on lignite or even peat or on natural gas.

Nuclear power development is generally based on atomic minerals particularly or uraniun or plutonium. Plutonium is a by-product of uranium fission and can be used instead of uranium as a nuclear fuel. The first nuclear power plant was built in Britain in 1956 at Calder Hall and there are now thirteen nuclear plants in Britain. But Britain has been rapidly overtaken in this field by the U.S.A. where there are already 20 stations in operation, 53 being built and another 36 planned. West Germany ranks second in nuclear plants followed by Japan, U.S.S.R., France and Canada. Fig. 12·9 shows the nuclear power generation capacity of major producers in 1971 and planned expansion of production.

NUCLEAR POWER IN INDIA

Having regard to the available energy resources, nuclear power is expected to play a progressively increasing part in meeting energy demands in future years.

APSARA, India's first reactor, incidentally the first reactor in Asia outside the U.S.S.R. It was designed, engineered and built entirely by the engineers and scientists of the Trombay Establish ment except for the fuel elements which were provided by the United Kingdom Atomic Energy Authority under an agreement.

Apsra, completed 25 years of operation on August 4, 1975· after operation for some 2·2 million kwh. In 1957 it operated for 17,800 kwh., in 1958 for 15,9,500 kwh and in 1959 for 6,62,200 kwh. During 1960, the reactor operated for 13,36,800 kwh. Upto Aug. 20,1960 when it was shut down for maintenance. The reactor is again in operation.

Cirus—The Canada-India Reactor (C.I.R) is India's second reactor, being a joint Indo-Canadian project under the Colombo Plan. It is a natural uranium-filled, heavy water moderated and light water cooled high flux research with a thermal power of 40 mw. The reactor is mostly used for scientific and technological operations, and for the production of large quantities of radioisotopes etc. Zerlina is Iadia's third reactor. The natural uranium fuel elements of cirus and Zerlina are fabricated in Trombay.

A nuclear power station at Tarapur, near Bombay, has gone in operation. It consists of two reactors of the boiling water type, and was built by the General Electric Company of the U.S.A. It consists of two reactors each producing 190 mw. of power.

A nuclear power station of the capacity of 200 mw. at Rana Pratap Sagar in Rajasthan has been completed and commissioned in 1969-70. Extension of the Rana Pratap Sagar nuclear station by 200 mw. and the establishment of the third nuclear station of 400 mw. capacity at Kalpakkam in Tamil Nadu and Narora in Uttar Pradesh have been sanctioned under the Fourth and Fifth Plans.

Tidal power, wind power, geo-thermal power and solar radiations are other possible sources but their impact on electricity development in India has been insignificant so far. Tidal and geo-thermal power plants have been in use only to a very limited extent. Research on direct conversion of solar energy into electricity is being carried out in many parts of the world.

France is the first country who utilized the tidal power as a source of energy. The tide, like the ocean waves, represents a vast store of energy, most of it apparently going to waste. In a very few places dams have been made to impound the water of the high tide stage, but, with this exception, man has made no direct use of this vast store of energy expending itself along the continental coasts.

PART V

BIOTIC RESOURCES

CHAPTER 13

BIOTIC RESOURCES

Biotic resources are often classified into two major groups. These are, first Animal resources and second forest resources.

COMPARISON BETWEEN ANIMAL AND FOREST RESOURCES

Animals and plants live in communities. Organisms in communities may live together because of common tolerances for the non-living environment or they may be unified by the interaction between the organisms themselves.

Animal resources and plant resources are extremely closely related, alike in their fundamental characters of both classes or kingdoms. The actual boundaries between animals and plants are artificial and are based on ecosystem. The animal and the plant alike require food to repair waste, to build up new tissue and to provide material which, by chemical change, may liberate the energy which appears in the processes of life. Both animals and plants take their water and inorganic salts directly as such. The animal cell can absorb its carbohydrate and protied food only in the form of complex organic substances: it is dependent, in fact, on the pre-existence of those organic substances, themselves the products of living matter, and in this respect the animal is essentially a parasite on existing animal and plant life. The plant, on the other hand, if to be green, containing chlorophyll, is capable, in the presence of light, of building up both carbohydrate material and proteid material from inorganic salts.

The distinctions between animal resources and plant resources are in fact obviously secondary and adaptive, and point clearly towards the conception of a common origin for the two forms of life, a conception which is made still more probale by the existence of many low forms in which the primary differences between animal resources and plant resources fade out.

An exact definition, delimiting all animals from all plants, is therefore impossible. In general, however, an animal is a living organism that is incapable of synthesizing carbohydrates and proteins from inorganic or simple organic substances, but must ingest them in complex form as food.

FOOD CYCLES

An important type of relationship within a community is that found in food chains and food cycles. The food cycle is the total

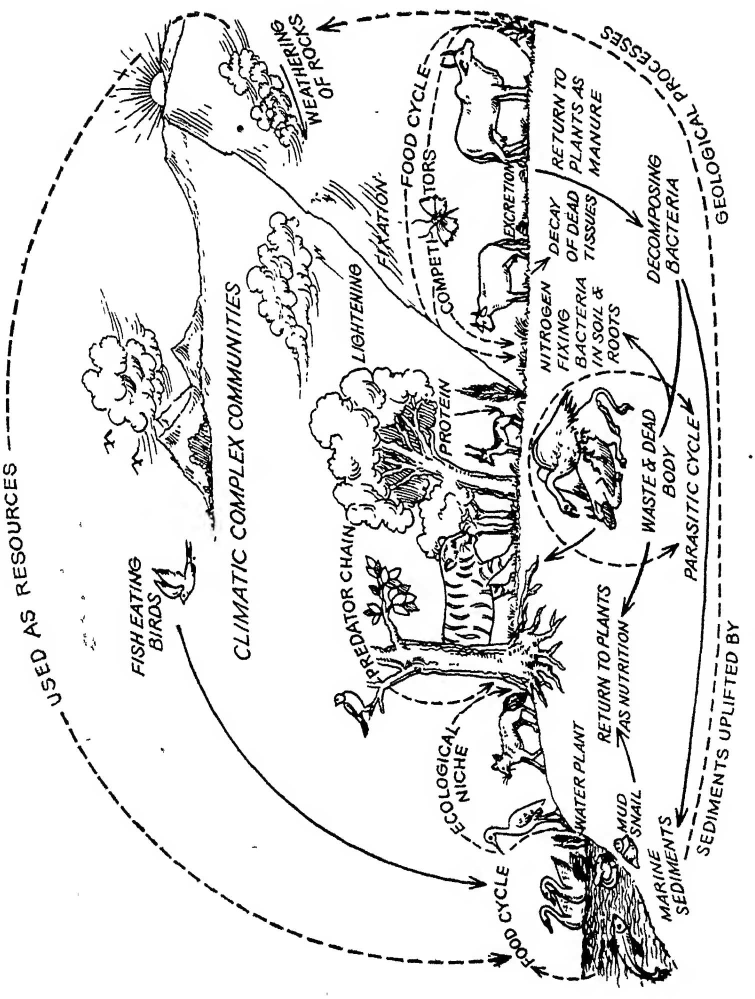

Fig. 13·1. Food Cycle

system of energy exchange of a biotic community, usually including a complex of interlocking food chains. The ultimate basis of all food chains and cycles is of course green plants able to utilize solar energy, though some particular communities may be based immediately on accumulating detritus, in soil, or in lake or ocean bottoms. A given food-chain typically consists of a series of links. The first link in the animal chain is usually some "key-industry" animal, small in size but present in enormous, numbers, such as midge larvae in lake bottoms or minute crustacea in the sea, and succeeding links consist of large and large predator types, ending in animals too large and too powerful to be preyed on by others. Some animals have bnen able to by pass the food chain, such as the giant whalebone whale that feeds directly on the minute key-industry crustacea. Some chains based on large mammalian herbivores may be very short, like the Savanna system of grass-deer-jagur. Food cycle of various climatic complex communities is given in Fig. 13·1. This figure shows that the predator chains, in general show a nice graduation in size A given predator species is usually limited to a rather definite size of prey; prey that is too large cannot be conveniently caught, killed or handled, and prey that is too small requires too great an effort to collect enough for proper nourishment. Parasitism involves a reversal of the size relations in predation chains, since the links are composed of successively smeller individuals. A particular link in a given type of food chain is often called an *ecological niche.*

The *ecological niche*, on the other hand, is the term that includes not only the physical space occupied by an organism, but also its functional role in the community. By analogy it may be said that the habitat is the organisms "address" or location and the niche is the profession. The species of the grasslands of temperate, semi-arid parts of Australia are largely different from those of a similar climatic region of South America but they perform the same basic function as primary producers in the ecosystem. Likewise, the bison of North American Prairies are *ecological equivalents* of the grazing Kangaroos of Australia since they have similar habitats. Ecological equivalent means that the organisms occupy the same or similar ecological niches in different regions are known as ecological equivalents. Thus the Kangaroo, bison, and cow although not closely related taxonomically occupy the same niche when present in grassland ecosystem.

Concentration on food chain relations emphasizes the "struggle for existence" in communities and in this it may be misleading. The prey-predator relation is not the only food relation : two animal species in a given community may be competitors for a given food supply, and they also may cooperate in the exploitation of a given food supply. The food supply of one animal is often the by product of the activity of another. The relations between communities are reciprocal. Thus the relations between species in a community are never entirely one-way. In ecological

parlance, any given communities are the product of climatic complex. In climatic complex many kinds of organisms are always associated together, and their relationships to each other as parts of the general environment are bewilderingly complex. The relationships between the biological community and the inorganic environment are reciprocal. The type of forest depends on the type of soil, but the soil type is also a product of the forest. The temperature, humidity and light conditions within the forest are the result of the vegetation; yet this forest climate in turn determines the type of community that inhabits the forest.

ANIMAL RESOURCES

Two principal subdivisions are recognized. They are—

1. **Land Animal** Resources just like sheep, goat, cow, buffalo, horse etc.
2. **Sea Animal** Resources such as various types of fisheries.

LAND ANIMAL RESOURCES

China has a largest cattle population in the world. According to the U.N. Statistical year book of 1972, there were in China 3775 lakhs heads of cattle including 2230 lakhs pigs. The second highest wealth of livestock is possessed by India, followed by the Soviet Union, U.S.A, Australia and Brazil etc. The total number of bovines are now expected to be of the order of 300,65 lakh. With growing livestock and human population, competition for land resources is increasing considerably. Inadequate supply of fodder results in poor quality of livestock and it not only impoverishes the farmer but also lowers national wealth and productivity. It is therefore, obvious that improvement of livestock cannot be satisfactorily brought about unless adequate steps are taken to augment the fodder resources of the world. At present we do not have very reliable estimates of total availability of fodder. This is mainly due to non-availability of estimates on average yields of various fodder crops. In old world there is a little likelihood of area under fodder crop incerasing appreciably in the near future, fodder resources must be estimated at the present production level and augmented not only by increasing the production per unit area, per unit time through adoption of high yielding disease resistent and nutritionally superior varieties, adoption of superior agronomic practices as applicable to these varieties and also introduction of fodder crops particularly legumes in crop rotation, multiple cropping along with the use of dual purpose of varieties and maximum conservation of seasonal surpluses of fodder wherever availabe.

LIVESTOCK CENSUS

The total livestock population of world (excluding poultry) was placed at 30065 lakhs according to 1972 livestock census. The following table 13·1 gives the livestock statistics of the world.

Table 13·1
Livestock of the world 1970–71*

(Figures in lakhs)

Country	Total	Cattles	Pigs	Sheep	Others
World	**30,065**	**11,412**	**6,677**	**10,747**	**1,229**
China	3,775	631	2,230	710	204
India	2,261	1,766	48	428	19
U.S S.R.	2,226	99	674	1,379	74
U.S.A.	2,096	1,146	675	196	78
Australia	2,057	244	26	1,783	4
Brazil	2,057	673	670	245	169
Argentina	1,018	498	43	438	39
New Zealand	684	88	6	589	1
Mexico	526	251	117	53	108
Great Britain	476	128	87	260	1
S. Africa	451	123	14	307	7
France	436	216	112	101	7
Iran	431	51	—	335	25
Germany	360	140	210	8	2
Spain	307	42	69	184	12
Colombia	286	211	38	17	20
Afghanistan	282	37	--	229	16
Canada	209	122	77	7	3
Indonesia	141	72	26	37	6
Denmark	115	27	86	1	1
Chile	114	30	12	68	4
Venezuela	112	85	17	1	9
Japan	106	36	69	---	1
Greece	99	10	4	77	8
Nepal	88	63	3	22	—
Burma	82	68	13	1	—
U.A.R.	55	21	—	20	14
Norway	32	9	6	17	—

GOATS

Goats form an integral part of agro-industrial sectors of economy. The goat is the principal source of meat supply ; it also provides manure, skin, hair (mohair) and in some cases also milk. In China, Great Britain, Europe and North America the domestic

* U.S. Sta. Year book 1972.

goat is primarily a milk producer. For large scale milk production goats are inferior to cattle in the temperate zone but superior in the torrid and frizzid zone. The goat is especially adapted to small scale production of milk for the family table but in Himalayan kingdoms of Nepal, Bhutan, it provides bread.

The goat has long been used as a source of milk, cheese, mohair and meat and its skin has been valued as a source of leather.

Of the Swiss goats, from which many of the best modern breeds are derived the Toggenburg and Saarien are most important. The French breeds have much Swissblood. In Germany the many varieties trace to Swiss breeds. There are many goats of Swiss type throughout Scandinavia and the Netherlands, where they are held in high esteem. The Maltese goat are found in Spain, northern Africa and Italy.

Nubians are African goats are mostly found in Egypt, Syria, Israel and arid regions of the world as shown in Fig 13·2.

Cashmere goat is famous in India, Pakistan and some parts of S. Eastern Asia, while Anglo-Nubians were important in America.

Of the wool goats there are two main types-Angoras have been established in South Africa, Australia and the United States and Canada. About three-quarters of the mohair produced in the United States comes from Texas. The Angora is a poor milker.

The cashmere goat which is known as shawl goat and is more like the common goat than the Angora. It is the undergrowth which is valuable. Cashmere goat is also known as *Pashmina* goat of Kashmir which produces an undercoat of very fine variety of hair which goes into the manufacture of Shawls.

SHEEP AND WOOL RESOURCE

Another livestock resource of the world is sheep and their wool, mutton production etc. Their distribution is widely divergent mainly dependent upon the climatic conditions the number being smaller in heavy rainfall areas and greater in light rainfall areas. Distribution of sheep is, of course, limited by grazing lands and somewhat by climatic conditions. Some cold areas, even if unfavourably wet, are usable, and warm areas, if dry, are used, but sheep are not numerous in the warmer areas of the Tropics. Fig. 13·3 shows the important cattle rearing regions of the world.

The distribution pattern of sheep differs from other livestock in the emphasis on the southern hemisphere. Entirely a development that occurred after 1850, it appears to be related, first, to the storability and transportability of wool, well adapted to frontier conditions of subhumid climates. In such subhumid areas the Marino sheep with its fine apparel wool developed under large scale ranching conditions. Later the development of refrigerated ocean shipping enable some of the thinly settled areas to increase the production of lamb for the European market.

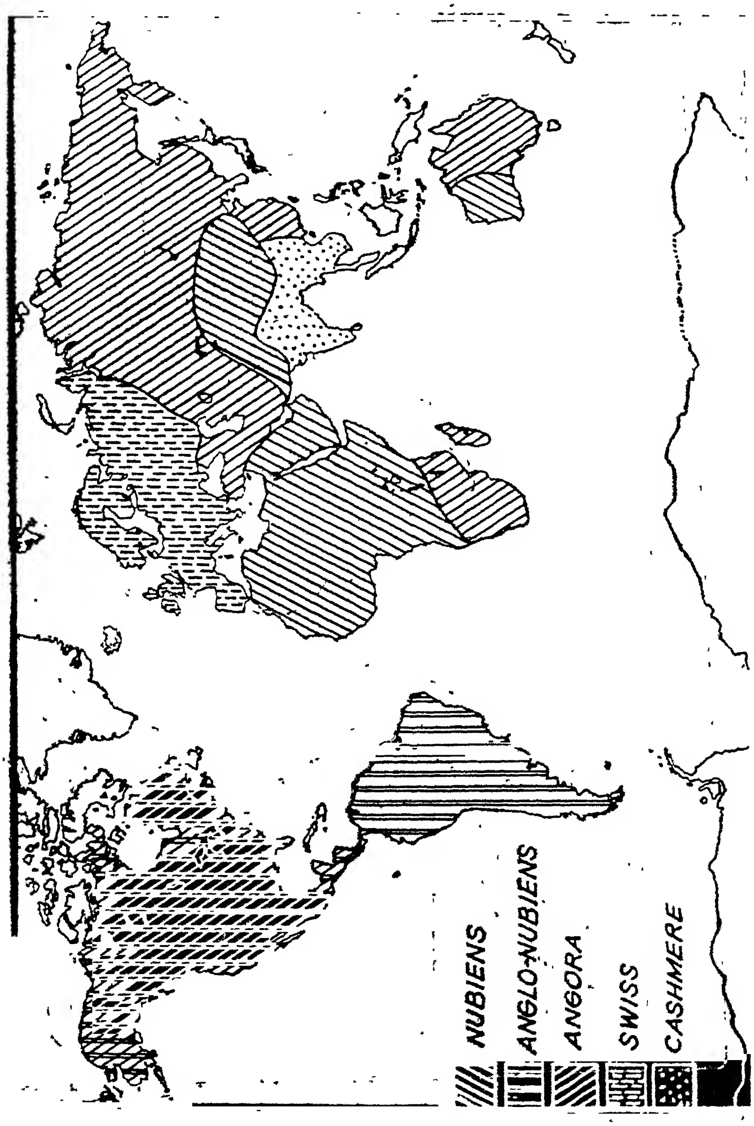

Fig. 13·2. Distribution of Goats

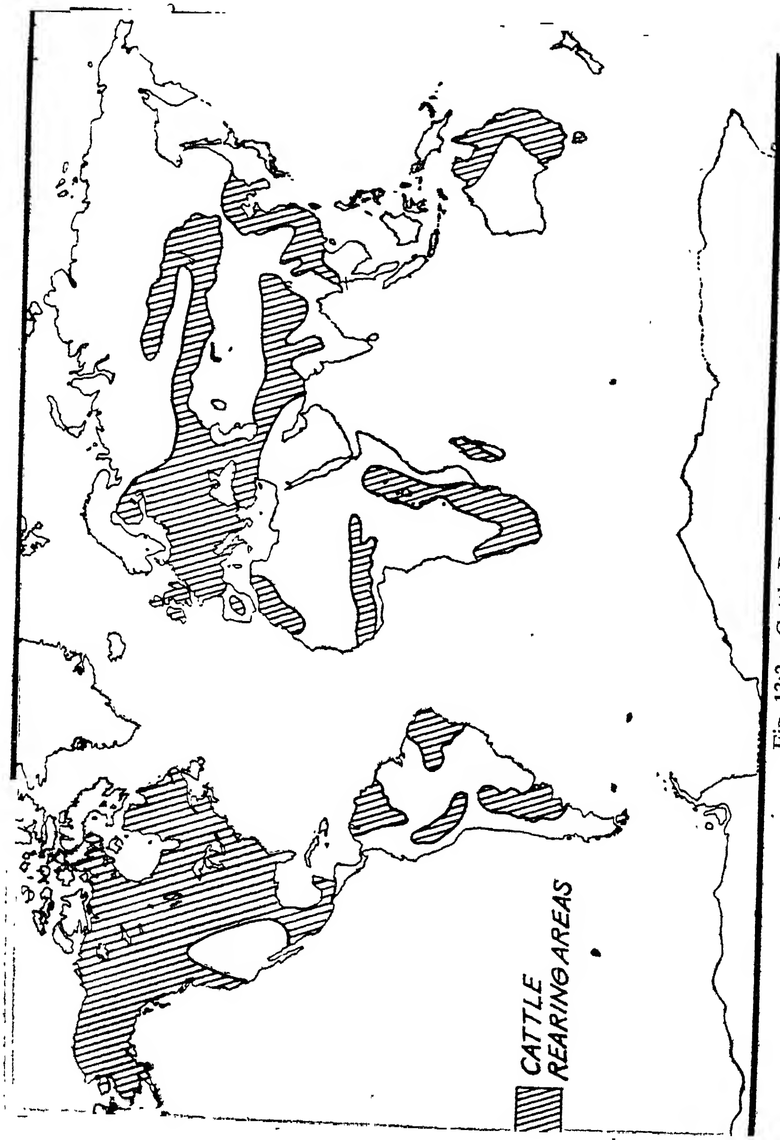

Fig. 13·3. Cattle Rearing regions

The Merino, a fine wool sheep, originated in Spain. It was known as early as the 12th century and may have been a moorish importation. It was particularly well adapted to semi-arid climates and to transhumance. It is a prominent breed in many countries, notably Australia, the United States, the Union of Soviet Socialist Republics, the Union of South Africa, Argentina, France and Germany. This breed has been designated by various names such as *Australian merino* in Australia and New Zealand, *American merino* and *Delaine merino* in the United States, Merino transhumante in Spain, *Merino Volosh* in the Union of Soviet Socialist Republics, *merino Argentino* in Argentina, *merino Precoce* in France and *Thuringia merino-ment* in Germany. Some of these names signify strains of the parent bread that have been modified by selective mating, but all the sheep have rather heavy fleeces of fine wool that is pure white when scoured

Merino wool can be woven into a fabric almost as sheer and resilient as silk, yet possessing greater strength and warmth. Environmental conditions, distance from market and economic competition also influenced sheep types. The semi-arid regions of Australia, where an area three-fifths as large as continental United States average only 45 cm. of rainfall a year and offers spare grazing of a weedy, shrubby character, are unsuitable for producing choice fat lambs, but the *merino* sheep with its excellent fleece of fine wool thrives there. *Karakul* sheep, which originated in Bukhara, are valuable chiefly for their lambs.

The Pamir Plateau, on the confines of Turkistan, at an elevation of 5300 metre above sea level, is the home of the magnificent *Ovis poli*, with a curve horns of great size. A variety inhabiting the Tien-Shan range is known as *Ovis poli Karelini*, and other racial forms occur in the mountains and lower ground of Turkistan, and in central Asia. *Ovis ammon* is mostly confined in Altai range, Ladakh, Tibet to Gobi desert. *Ovis Canadensis stonei* is widespread in Alaska, Yukon, Rocky mountain to central America. Cameroon and *Ovis jubata*, a hairy sheep, mostly found in Africa.*

There are some good sheep in parts of India like *Bikaneri* rams which are of woolly type. The wool produced in India is also of much inferior quality. As an exception, the kashmere goats are famous for fineness of their wool.

By the mid 1950's world sheep numbers increased nearly 22% as compared with pre-world war II figures, with major increases reported for the U.S.S.R. and Australia. There were increases in all continents except North America, where sheep numbers decreased by 35 percent. The decline in the United States is difficult to understand at first glance. One might think that emphasis on soil conservation, grassland farming, new development in better adapted and more productive grasses and the adoption of new ways of

* Newbigin, M I.—Plant and Animal Geography, p.p. 224–225.

curing hay and making and using grass silage should have led to increased sheep production.

The wool-producing countries are the Australia, Newzealand, U.S.A., U.S.S R., Argentina, France, Germany, China, Turkey, Union of South Africa etc.

The sheep do not only provide cool, but also mutton, manure, pelts, hair, milk, butter and serve as pack animals to carry essential food grains from their owners, across the precipitous hills where other systems of transport would perhaps fail. In addition, the pelt is a major by-product of sheep slaughter. The pelts, with the wool removed, known as slates, are tanned for leather which is used for upholstery, bookbinding, gloves, clothing and shoe uppers. With the wool, the pelts are a basic material for the manufacture of durable and warm outer-clothing. Not only the carcass as such but the liver, heart, kidney and some other parts are used for human food. Some of the internal glands have pharmaceutical uses. The small intestines are valuable sausage casings and are significant in international trade. They also are used to make surgical and musical catgut. Wool grease or lanolin has important uses in lubricants, ointments and cosmetics. Sheep tallow has both edible and inedible uses. Live sheep enter international trade in comparatively small numbers, mostly as select breeding stock.

The carpet wool produced in India is classified in the world markets as East Indian type of wool and is sold under well-known names *Joria* and *Bikaneri*. The *Bikaneri* breed hailing from the desert of Bikaner is hardiest breed known in India. This breed is becoming a consumption breed of India and is being introduced in different states. The fact that India is ond of the main producers of carpet wool, need not give an erroneous impression that India produces only this wool. This country also produces large quantities of fine wool, specially in the hills of the Panjab, Uttar Pradesh, Himachal Pradesh and Kashmir. In Himalayan regions and in the western portions of the Deccan plateau, breeding the imported merino with the local sheep, has shown great promise.

CATTLE REARING ECONOMIES

Cattle are extensively reared on the grass-lands of Europe, India, the United States, Argentina, Brazil and Australia. The chief regions for exporting beef are Argentina, Brazil, Australia and New Zealand. In developing countries most of the work of ploughing and harrowing is still done by animals (mainly oxen and water buffaloes, but also horses, donkeys and mules). Fig. 13·4. shows the livestock economies of the world. Map description is given below.

Largely Commercial

1. Intensive cattle, pig, horse, sheep and poultry raising.

2. Intensive sheep and cattle raising; Ostrich farms in South America.

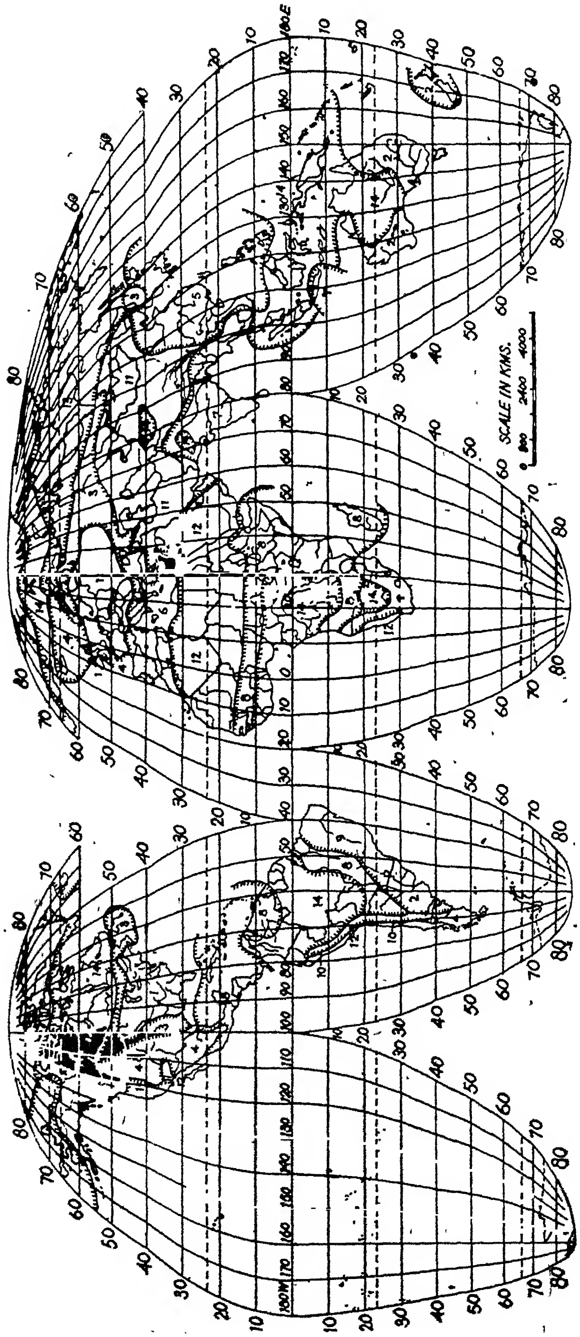

Fig. 13·4. Livestock Economies of the World.

3. Extensive cattle, sheep, and horse raising; fur farming.
4. Extensive sheep and cattle raising.

Largely Subsistence

5. Intensive pig and poultry raising, water buffalos, goats.
6. Intensive sheep and goat raising, oxen, water buffalo, donkey, mule etc.
7. Extensive sheep and goat raising; water buffalo, elephant.
8. Extensive cattle and goat raising.
9. Extensive cattle and pig raising, donkeys mules.

Largely Subsistence

10. Extensive sheep, Ilama and alpaca raising.
11. Extensive horse, sheep, cattle and camel raising; Yak in Tibet.
12. Extensive horse and camel raising in Africa-Arabia; water buffalo and mule in ocases; in United States ocases :

European and Zebu cattle, sheep.

13. Extensive reindeer raising.
14. Practically no livestock.

The farmer of India keeps cattle primarily for the purpose of drought for the plough or the cart, although in most parts of the world food and milk are the primary purposes for which they are kept.

Importance of Cattle in National Economy

An immense wealth of livestock is possessed by India. Unfortunately, the productive capacity of Indian animals is extremely poor. Cattle and buffaloes occupy a premier position among the various species of livestock; and unlike in other countries, cattle are an integral part of our agriculture sector of economy.

1. Cattle provide milk and milk products : The productivity of Indian livestock is generally low. Although high individual yields of milk are obtained in some breeds of cattle there is evidence of slight increase. India's average yields continue to be extremely small.

Milk has been taken by man at various times and places from camels, sheep, goats, cows, yaks, water buffaloes, reindeer and other animals. Cows, goats and sheep have long been adapted for milk production. Milk is a perfect food and ranks high in protein and is substitute for meat in many localities.

In developing countries milk yielded is used mostly for making *ghee* or purefied butter which is sold in cities. Of the total milk produced in India, about 38 percent is estimated as being used for consumption as fluid milk, about 42 percent as *ghee* and the rest as butter, khoa, curd and other products. In Indian Republic the largest number of milk yielding animals is in Rajasthan, followed

by Madhya Pradesh and Uttar Pradesh, where the area under cultivation is largest. Therefore the fodder problem is acute.

Our land resources in India is limited and there is a competition between the man and the livestock on the land for food production. Each and every country of the world is very much conscious about the problems and this is being tackled by reducing cattle population on one side and increasing the per capita production on the other side. The increased productive efficiency is not only required to release pressure on land but also to compensate inflation, Unless the production ability of an animal increased or it is inversely proportional to the reduced money value the price of the livestock produces will be beyond the purchasing capacity of the consumers. In the United States during the year 1944 the population of cattle was 26 million with an average annual production of 2000 litres per head where as in the year 1960 the population of dairy cattle has gone down to 19 million that is about 30 percent and the per capita production per cow has gone up to 3000 litres per head per annum that is by about 50 percent.

This improvement in per capita milk production in the United States is being achieved through the process of selective breeding where the rate of genetic improvement is very low. Since 19th century crossbreeding of indigenous cattle with exotic bulls is being carried out in India. Increase in milk production in the crossbreed cows is considerable and about 2000 litres per head per annum as against 275 litres average production of indigenous cow. Unlike developed countries where they are left with only process of selective breeding for the increase in milk production. We are in an advantageous position to increase our milk production at a much higer rate than the population growth to meet up our demand within shortest possible period. Incread milk production in India is not only required for higher nutritional standard but also to improve the socio-economic condition. This is more vital function since through milk production alone and also the subsidiary industries based on milk production millions of people of India are finding their self-employment. According to the livestock census 1966 there are 46·78 million cows and 23·36 million buffaloes over three years of age fit for breading and milk production and daily per capita availability of milk works out to 112 grams only.

2. To help Agricultural operations—These animals are kept for breeding bullocks and buffaloes that are needed for agricultural operations. Their main purpose, therefore, is not milk producton but to help agriculture. Cattle play very important part in Indian agriculture and also other developing agricultural countries. In India, Pakistan, China and other countries of the South and Far East few cattle are kept for meat or milk, while cattle play very important part in Indian agriculture. "But unlike the other countries of the world, whose cattle are maintained mainly for milk

and meat, in India these are primarily kept as draught animals for the plough or the cart as the camel, the horse, the donkey and mechanical vehicles are rarely used. Without them no cultivation would be possible, without them no produce can be transported." [1]

3. As a means of transport. Cattle serve in transport too : According to the Report of Royal Commission on Agriculture. "In most parts of the world cattle are valued for food and milk, but in India their primary purpose is draught for the plough and for the cart."

4. Cattle also provide the farmyard manure which promotes the productivity of the soil: One cow usually provides with 30 quintals of dug and 16 quintals of urine per year.

5. Livestock is a valuable source of Animal protein. Protein calorie mal-nutrition is widely prevalent among the poor segments of population throughout the world, though to different degrees is different regions. Available evidence indicates that severe degrees of protein-calorie malnutrition are seen along the rice-eating belt of monsoon lands. The largest consumption of meat per capita is found in the midst of great surplus producing areas such as New-Zealand and Australia, Uruguay, Argentina etc. Denmark consumes more meat than any other nation of Europe. Table 13·2 shows the per capita consumption of meat in various countries of the world.

Table 13·2

Meat Supply and Consumption of Selected countries

Country	**Per capita Consumption (in pounds)**	**Production in million pounds**
Uruguay	243	823
Argentina	230	4,800
New Zealand	220	1,296
Australia	208	2,309
United States	144	23,035
Canada	123	19,77
Denmark	108	1,193
France	105	4,450
Sweden	100	702
Great Britain	96	2880
Switzerland	91	424
W. Germany	89	4,450
Cuba	79	1,970

1. Report of the Royal Commission on Agriculture, p. 169.

Netherlands	38	1,042
U. of S. Africa	74	935
Portugal	40	345
Italy	34	1,485
Chile	64	381
Brazil	57	3,150
India	5	1,645
Japan	4	369

Uruguay ranks first is meat consumption while the United States is chief meat producing country of the world, About 60 percent area of Uruguay is suitable for grazing, and the wealth of the country chiefly comes from the stock raising industry, particularly cattle and sheep. The greatest source of income at present is wool. According to live-stock census the livestock population of Uruguay consists basically of about 8·1 million cattle 22·8 million sheep and 400,000 pigs. Of the cattle population some 600,000 are dairy cows. In 1972–73 wool clip was estimated at 60,000 tons.

Cattle raising is Argentina's oldest industry in the western hemisphere. Meat referigeration is under state control exercised through the Argentina Meat Board, which extends its supervision to all stages of cattle raising, from breeding to distribution. The products of stock raising include wool (10 percent the world output, hides, horsehair and a wide range of by products. The products of stock raising account for about 50 percent of total exports; they include chilled, frozen and canned meat (of which the U.K. is the biggest single buyer), wool and hides. Pastoral and agricultural products provide more than 90 percent of Argentina's exports and they originate mainly from the Pampas or rich central plain which Cmbraces the provinces of Buenos Aires, Santa Fe,' Entre Rios, Cordoba and La Pampa Fig 13·5 shows the livestock rearing regions of Argentina and Uruguay.

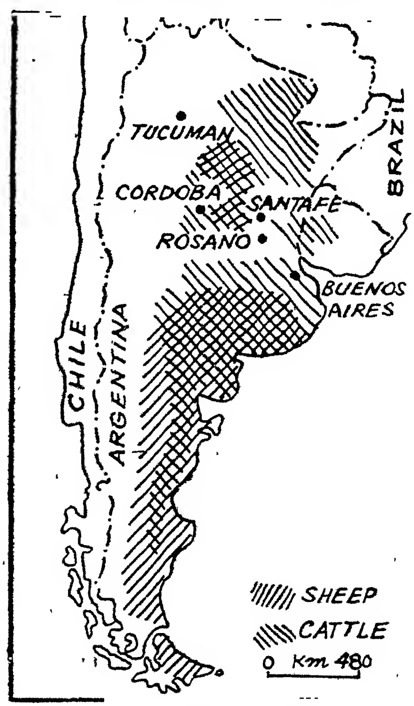

Fig. 13·5 Livestock rearing regions

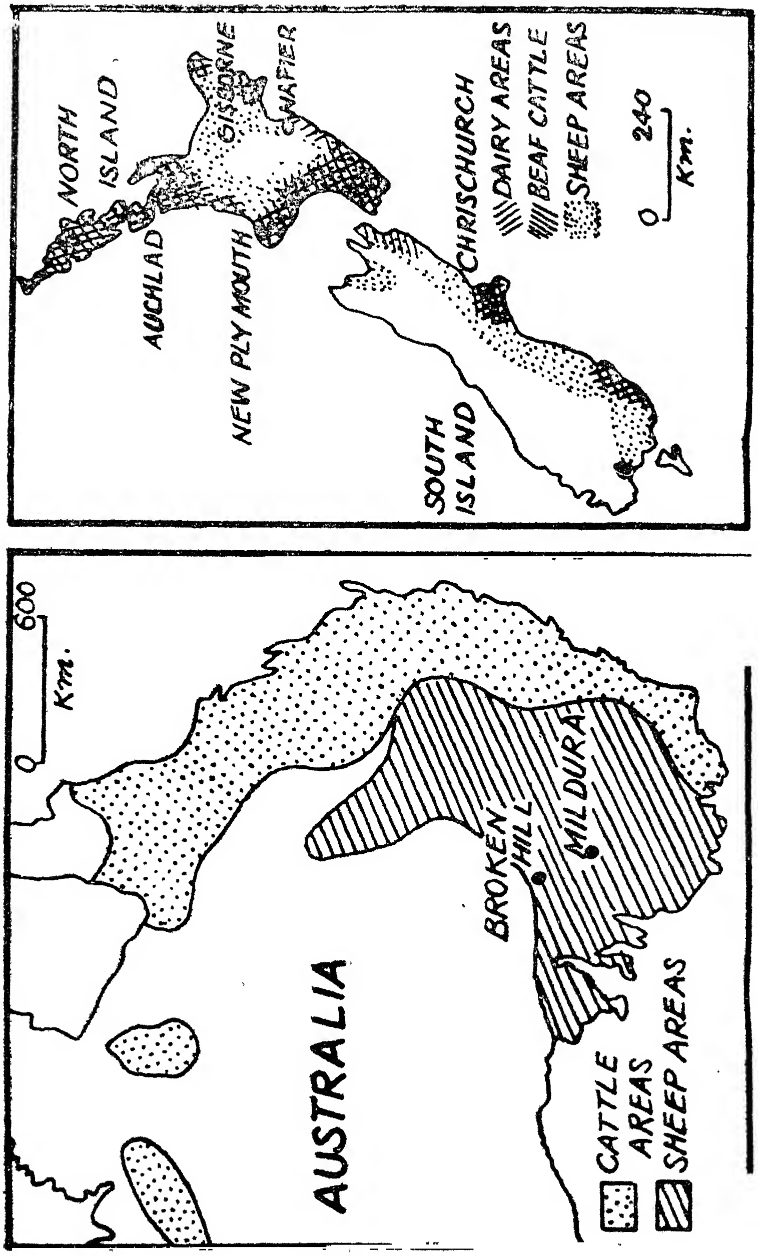

Fig. 13.6 Livestock Rearing of Australia and New Zealand

Cattle herding in Africa is carried on jointly with Agriculture on the plateau, and it is estimated that there are 66 million head of cattle in the whole country. Ethiopia is most important cattle rearing country of Africa. These are mostly cattle belonging to the Zebu type, which is humped, and they are used both for work and for milk Sheep and goats are also kept, but the wool is of poor quality. The horses are small and sturdy, and are found all over the uplands of the continent, as are mules, which are used mainly for transport in broken country.

The greater part of New Zealand, as in Australia, is under fodder crops; swedes, turnips, rape and kale are grown extensively. Over much of the country grass is the most valuable crop and provides all the year round grazing for livestock. Herd and flock sizes are steadily being increased to keep farming economic. Liquid milk production during the year ended May 1972 amounted to 1380 million gallons, of which only 111·3 million gallons was consumed as whole milk or cream. The remainder was made into butter, cheese, milk power or casein.

Cattle raising plays an important part in the national economy of Australia. Although Australia has about 2% of the world's cattle but is a major beef exporter. Beef cattle are kept mainly in the north of the country on the Savanna grasslands, but due to more careful management. Cattle raising in Australian Savanna is more successful than in most Tropical regions. More than a third of Australias cattle are concentrated in Queensland and another third in New South Wales and Victoria as shown in fig. 13·6.

Livestock was considerably reduced in European countries during world war II. Sheep and goat rearing in vital to the national economy of Britain and Scotland. Cattle rearing is important occupation of some European countries.

WORLD DISTRIBUTION OF DAIRY

The greatest dairying areas are the pastural lands of U.S.A., Australia, NewZealand, western Europe and temperate parts of the Soviet Union. The Union of Soviet Socialist Republic is the largest producer of milk and butter in the world. Dairy farming is developed predominantly in the central and northern belts of the European part of the country and also in western Siberia. In the vicinity of big towns it specializes in the production of milk, while far from urban localities its milk output is processed into butter or cheese. Another area with a growing dairy output is wes ern Siberia and northern Kazakhastan, central Asia, where dairy with agriculture is important occupation of the peoples. Mild yields in the Soviet Union tend to be rather low by European standards as show in table 13·3.

Table 13·3
Average milk yields per cow for selected countries (Kg. per cow per year)*

Country	Yield per cow per year	Milk Production (1972) (million tons)
Japan	4310	49
Netherlands	4233	87
U.S.A.	4001	545
Denmark	3875	48
U.K.	3830	142
W. Germany	3707	214
Taiwan	3500	N.A.
S. Korea	3450	N.A.
France	3170	303
New Zealand	2906	63
Italy	2030	97
U.S.S.R.	1948	832
Chile	1750	N.A.
Kenya	1620	N.A.
Greece	1147	N.A.
Burma	820	N.A.
Peru	670	N.A.
Malaysia	580	N.A.
Argentina	450	54
India	448	237

The U.S.A. is the second largest milk and butter producer and leads in cheese production. Like the USSR it has a larger domestic demand for dairy products and has only a small surplus for export. The chief dairying region of U.S A. is the hay and dairy belt south of the Great Lakes in the states of Wisconsin, Minnesota and parts of Dakota, 32·6% of the total cow population being found in these states. Wisconsin alone possessed 10% of the nation's dairy cows. Another region where dairying is becoming much more important in North America is in Lake Peninsula and the St. Lawrence lowlands of Canada.

Dairying is well developed throughout north western Europe i.e Denmark, the Netherlands, Belgium, France ete. In the production of cheese, the United States was followed by Italy, France, West Germany and the Netherlanc s. The tiny kingdom of Denmark is famous for butter in the world market, and now ranks second to New Zealand in butter exports. West Germany, Southern Norway, and Southern Sweden also have well developed dairy industries.

*F.A.O. Production Year Book, various vols.

Each of these countries uses about one half its milk supply in making butter. Switzerland, like Great Britain, has an ideal climate for dairying. In Switzerland about 70% of available agricultural land is used for dairy farming, and transhumance is practised in the rugged mountain valleys. Dairying activities are also important in Mediterranean region of Europe. Other European dairying countries include Czechoslovakia, Italy and Austria, Greece and Bulgaria are famous for cheese production. Britain produces about 5% of the world's milk and also noted for cheese. The major dairying regions are the central Lowlands of Scotland, the Lowlands of Herefordshire and Gloucestershire, South west England, the Lancashire and Cheshire plain etc.

NewZealand in the Second half of the 20th century was the most intensive dairying country in the world when milk production per capita was used as the yardstick. At present NewZealand is the world's leading butter exporter accounting for 29% of the world total. The leading market for NewZealand butter is Britain.

In Australia commercial dairying activities are restricted to only humid regions of Victoria, New South Wales and some parts of South-east Queensland. These areas are the most coolest and rainiest part of a warm dry continent.

Dairying in India

The dairying industry in India is unique in several ways. The production of 24 million tonnes of milk per annum is controlled by a large number of people. In our country we do not have large farmers producing milk in a modern way as in other more prosperous countries. On the other hand, in villages, dairying is the business of the house wife who has not been educated in modern methods of dairying; much less in the methods of hygienic milk production. Again, nowhere else in the world, milk produced by an animal other than the cow, plays such an important role in the dairy production as in India. More than fifty percent of our milk production is from buffaloes. Even though our country ranks lowest among the milk producing countries of the world, the per capita availability of milk is only 110 ml. per day, a quantity which is not even half of what the nutritionists tell is necessary for minimum nutrition.

A recent estimate of the Planning Commission has indicated that in most states of the country the poverty line—the percentage of the people whose private consumption per capita is less than Rs. 40/- is as high as 41·3% in Karnataka, 40·4% in Tamil Nadu, 37·9% in Kerala and 33·5% in Maharashtra. This segment of population is unable to buy milk. A recent survey of the Protein Foods and Nutrition Developmemt Association of India carried out in the Four Southern states has confirmed that 85 to 90% of the families do not buy milk. Thus the major need at the moment is to increase the production of milk and at the same time reduce cost of production. It is in this background that the technology of dairy products assumes an important role. We have areas in the

country where milk is surplus. Gujarat and Haryana where the per capita consumption of milk is very much higher and where during the winter months milk is produced in abundance and much more than the local requirements. Utilization of the milk and milk products has a great potential in urban areas.

With the advent of rapid growth of industries, the population in urban areas is steadily increasing and so also the demand for milk which is an important item of diet of our population, majority of whom are vegetarians. The market and distribution of milk in urban sector is controlled by thousands of *halwais* and *dudhiyas* or milkmen, who indulge in unscrupulous practices. The Government of India, therefore, felt the necessity of supplying clean and hygienic milk to the urban population at reasonable prices in an organized way by establishing milk supply schemes in all important cities and towns during 2nd, 3rd and 4th Five Year Plans. The Government established 169 plants in various parts of the country and another 25 are expected to come up by the beginning of Fifth Five Year Plan.

The seven milk products factories at Anand, Amritsar, Mehsana, Jind, Moradabad, Vijayawada and Rajkot manufactured about 45 tonnes of milk powder including milk food per day as against 40 tons daily in the preceding year.

The distribution of dairy products is almost world wide.. Improvements in production and processing techniques have made it possible to keep milk in the fresh condition for many weeks and to ship it around the world. In nations having an advanced dairy industry, distribution of milk in bottles or cartons is the general practice but in some other countries milk is carried in bulk to homes and dispensed into containers provided by the housewife. Milk provides nearly all the nutritive factors essential to a good diet. These are combined in the proportions and amounts needed for the growth of infacts and childern and the promotion of nutritive welfare in the adult. Milk contains about 3·9% butterfat, 3·5% protein, 4·8% milk sugar and 0·7% minerals, as well as vitamins. The resulting product, butter, contains from 80% to 85% milk fact, less than 1% protein and about 16% water.

New Zealand, Denmark, Australia, the Netherlands and the Uuited States were leading exporters of butter and cheese. The Netherlands led in the exporters of condensed milk and the United States in the exporting of milk powder. Argentina is a leading exporter of casein. Of the world production of almost 260,000 metric tons of milk 89% consisted of cows milk, 6% buffalo milk 3% goat milk and 2% sheep milk.

PIGS AND POULTRY

Pigs are omnivorous feeders, eating practically anything that is given to them, including domestic and farm wastes, roots, leaves and even night soil. In western countries especially U.S.A. where

pigs are tamed on corn. But the best forage crops for pigs as for other animals are cereals, such as maize, oats, sorghum, soyabeans etc. In U.S.A. especially in the corn belt where the bulk of America's 50 million pigs are found, they are fed on such crops. At present there are hundreds of bacon factories, pig breeding farms and piggery development blocks in various states of U.S.A There are many meat-packing centres in the States such as Chicago, St. Paul Sioux city, St. Louis and Omaha.

Federal Republic of Germany, China, Brazil, Poland and Great Britain are the largest pig producers but many other countries including Bulgaria, Belgium, Ecuador, Finland etc. all have large numbers of pigs. Denmark is the bacon specialist and leading world bacon exporter of the world. In old world, Peoples Republic of China is the most important pig-rearing country of the world. Table 13·4 shows the Pig production.

Table 13·4
Numbers of Pigs in selected countries*

Country	Numbers of Pigs
Uruguay	40,000
Brazil	66,374,000
Austria	3,091,000
Belgium	3,924,000
Bulgaria	2,806,000
China	166,000,000
Denmark	8000,000
Czechoslovakia	6,090,000
Ecuador	236,670
Finland	1,182,500
Federal Republic of Germany	209,600,000
Greece	383,000
Poland	15,240,000
England	9,000,000

POULTRY

The demand for poultry and eggs increasing enormously due to general improvement in the economic level of the people and greater appreciation of nutrition in general and food value of poultry products in particular, as eggs and poultry meat are one of the richest sources of animal protein. Prices of poultry and poultry products are attractive for the producers.

The U.S.S.R ranks first in world poultry population with 516 millions. The United States, the world's second greatest poultry producer has some 480 million which lay 70,000 million eggs a year Production of mutton is not keeping pace with the

* The International Statistical Yeav Book 1974.

rising demand. It is poultry, which can be produced on a large scale in a relatively much shorter time and at comparatively less cost, that will try to meet the ever increasing demand of meat. The largest egg producers countries are the United States, the U.S.S.R., Japan, Great Britain, West Germany and France. Other countries including Brazil, Poland, Italy and India all have large numbers of poultry. Table 13·5 shows the poultry numers and their production in selected countries.

Table 13·5
Poultry numbers and production of eggs.[1]

Country	Number of Poultry (millions)	Number of eggs (millions)	Produciton of edilbe Poultry (thousand tons)
U.S.S.R.	516·2	33,300	800
China	480·0	N.A.	N.A.
U.S.A.	434·9	70,161	5,624
Brazil	268·0	8,750	185
France	237·0	10,000	640
Poland	166·2	6,348	107
Indonesia	126·5	3,125	22
Japan	126·3	21,744	212
U.K.	125·4	14,988	439
India	115·2	2,152	69
Mexico	110·0	8,430	69
Italy	110·0	8,430	375
W. Germany	91·9	13,802	204
Canada	89·8	5,306	470
Philippines	69·0	1,366	40
Nigeria	66·0	1,120	N.A.
Ethiopia	43·0	1,530	52
Uruguay	6·0	N.A.	N.A.
Bulgaria	37·0	N.A.	N.A.
Denmark	7·0	N.A.	N.A.
Czechoslovakia	39·0	N.A.	N.A
Finland	3·7	N.A.	N.A

Other products such as hides and skins are the important source of income from livestock. Most sheep and goats are slaughtered for consumption directly from pasture or the range. Exports from particular countries vary widely from year to year but come

1. F.A.O. Production Year Book, The International Year Book 1974 and other various publications. N.A.=Not available.

largely from the following countries in approximate amounts, which is shown in table 13·6.

Table 13·6

Hides and Skin production for selected countries.[1]

Country	Cattle Hides Production (tons)	Country	Sheep Skins Production (tons)
Brazil	15,900	New Zealand	3,900
France	11,500	Spain	1,700
W. Germany	10,800	France	1,280
Great Britain	9,200	Australia	1,700
Mexico	5,200	Argentina	400
India	17,000		

Figures for many countries with a large production i.e. the U.S.S.R., the U.S.A., China and African countries are not available India produces about 32 percent of the world's hides and skins. India is the largest exporting country of the world for hides and skins and its products.

MUTTON

The animal most used for slaughter for meat is the goat. The largest number of goats are in U.S.S.R, Turkey, Australia, U.S.A., and S. Africa. Meat is the most important exports item. Argentinas beef production in 1972 was 2·8 million tons and exports reached 650 thonsand tons of which 124 thousand tons went to the U.K. In 1969 export sales for veal—totalled 74,000 tons, of which 25000 tones went tothe Great Britain. Agrentina is preeminent in the production of beef, mutton and wool, being self sufficient in basic food stuffs and conducting a large export trade in many others.

Pastoral production and in particular sheep farming are of prime importance in Australia. Wool alone contributes about one-fifth of the total value of Australian exports.

Denmark is rich in dairy products. The figure of livestock production is as–milk 4789 tons, butter 136 tons, cheese 131 tons, beef 191 tons, pork 819 tons. The figure for poultry is merely that of chickens for slaughter. There has been a big increase in pig production and about 12,000,000 are killed annually. The pig population in China during 1972 was 2230 million. Chickens, ducks and geese are also raised in large numbers and are an important source of peasant income in some areas of Peoples Republic of China.

New Zealand is now the world's leading meat exporting country. There are 42 freezing works from which the frozen meat is taken in specially insulated vans to the wharves and shipped abroad in vessels with specially fitted refrigeration chambers or containers.

1. F.A.O. Production year book and the international year book 1974.

Cattle raising is carried on successfully in the Savannah country. Animals are slaughtered for consumption within the country and the hides are exported.

FUR FARMING

Most of the world's best known Fur bearing animals come from Northern hemisphere, especially U.S.S.R., Canada and Taiga belt of forest. Wild furs come not only from cold climates, as is commonly believed, but from temperate and tropical zones as well. The Fur trade reaches from the Arctic areas of Siberia and Canada to the Southernmost tip of Africa for almost eighty varieties of furs which can be made into apparel. Still, the most important sources of supply are the cold regions where the temperature ensures the growth of thick, luxuriant fur.

Noth America is the home of the greatest variety of fur bearers. Canada is famous for fox farming.[1] There are more than forty different types of indigenous furs.

Northern and central Europe and Siberia supply badger, beaver, ermine, fox, hare, lynx, mink, muskrat, moleskin etc. The latter fur is found in the British Isles and in the Neatherlands, France and parts of Africa. Tremendous quantities of rabbit skins are pelted in Australia, France, Belgium and Great Britain. The main item of exports by Trans Siberian and Trans Pacific Railways are fur and forest products. China delivers marmot, kolinsky, kid, goat and lamb. Korea supplies kolinsky. India, like Burma and Sri Lanka, contributes Leopard, tiger and ocelot but their hunting is now restricted according to wild life preservation act.

1. Taylor, G.—Canada, p. 49.

CHAPTER 14

FISHERIES—A FUTURE RESOURCE

In early times, before intensive agriculture was practised, fisheries were relatively more important than they are today. The quantities taken were smaller, but fish formed a large proportion of the food supply. With most of the world's productive land now in use, and with rapidly expanding food requirements, mankind is, of necessity, looking to the sea to supply a part of the additional food needed to provide an adequate diet fort he world's population.

Value of Fish food

There is a wide range in the consumption of fishery products in various countries. The Food and Agriculture Organization of the United Nations has found that annual consumption in most countries is less than 10 lb. per capita per annum. The annual fish consumption per capita is given in table 14.1.

Table 14·1

World Consumption of Fish *

Country	Cousumption in kg. (per capita)
Portugal	45
Japan	45
Denmark	27
Norway	37
Sweden	41
Taiwan	36
Malaysia	29
U.K.	13
U.S.A.	10
Australia	9
Argentina	5

Fish are a vital source of food, especially in countries like Japan, Norway, Sweden, Iceland and Greenland where the lands is bleak or mountainous and agriculture cannot be easily developed; and fish are also caught and processed to produce lubricants, fertilizers or cosmetics.

In addition to taste appeal and great variety, fish deserve inclusion in the family diet on the basis of actual food value. Protein, fat, minerals and vitamins are the food elements in fishery

*Various sources.

products. In fact, about three-quarters of the total fish catch is used for food, whether fresh or processed, as shown in table 14·2.

Table 14 2

Percentage of uses of world total fish haul

Category	Percentage
Fresh or frozen fish	28
Aquantic animal meals and solubles	26
Aquantic animal oils and fats	14
Dried, salted or smoked fish	13
Canned fish	13
Crustacea molluscs, fresh or preserved	5
others	1

Fish are rich in animal protein—the substance that replaces worn-out body tissue and promotes growth. Fig. 14·1 shows the protein intake of the world. An average serving of fish or shell fish will supply the animal protein necessary for properly balancing the less efficient cereat and vegetable proteins in the daily diet. Fish are also valuable because of their mineral content, iron, copper, magnesium, iodine, calcium and phosphorus—all essential to human well-being—are a few of the minerals that have been accumulating in the sea for thousands of years. Through complex food chains (as shown in fig 14·2) these minerals enter into the bodies of small sea animals which, in turn, are eaten by fish. Fish liver oils have long been known to be rich source of vitamins A and D.

In addition to use as human food, large quantities of fish and shell fish are used in the manufacture of by products. An important portion of the world catch is utilized directly in the production of fish meal, oil and other products, and great quantities of waste from canning, filleting, and otherwise preparing fishery products for human food are also used in the production of by products. Where as large quantities of fish meal were formerly used as fertilizer, nearly the entire production is now used for animal food. The meal provides protein of high biological value and other elements which makes it valuable in relations for poultry, pigs any young cattle.

Fish whale and other marine animal oils have a large number of industrial uses. They are used in the treating of leather and in the manufacture of soap, paint, printing ink, linoleum, oil cloth, lubricants and greases, and many onther products. Large quantities are also used in the manufacture of margarine. Certain fish body oils have sufficiently high vitamin A and D potency to make them valuable as feeding oils for poultry. Fish liver oils also are important source of vitamins A and D for human and animal nutrition. Cod liver has been a valuable source of vitamin D for over 100 years,

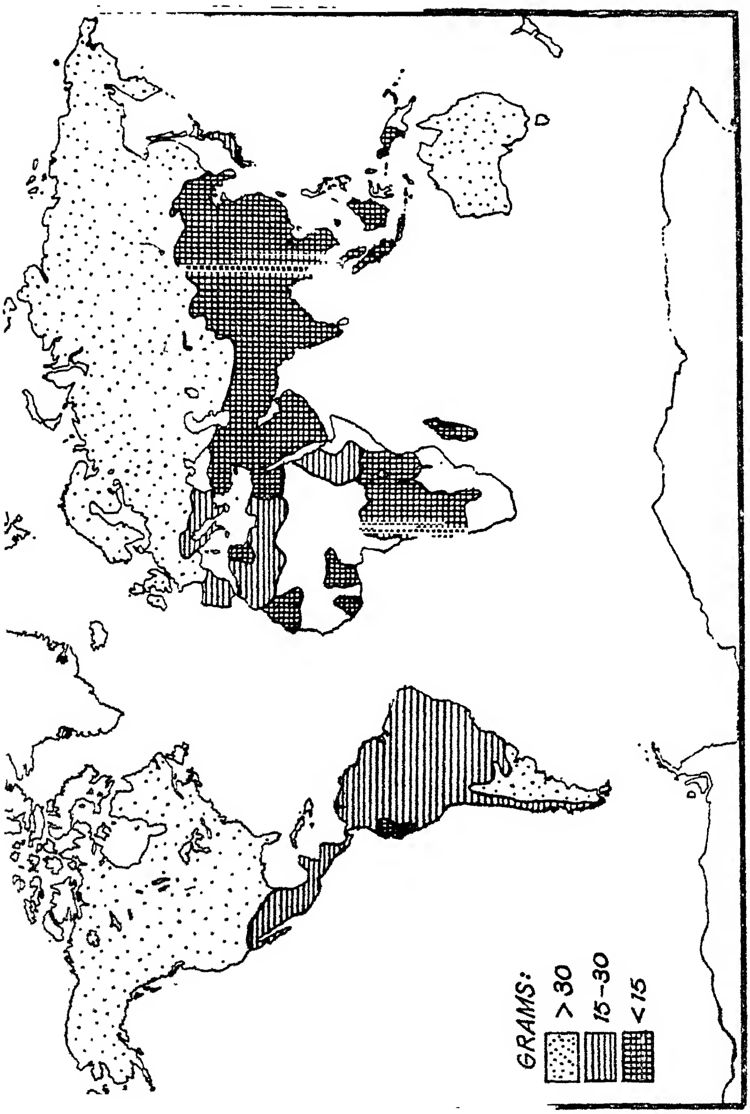

Fig. 14·1. Protein intake of the world

but only recently has it been known that the livers of such species as sharks, halibut, swordfish, sablefish, lingcod, tuna and others are even richer sources of vitamins A and D.

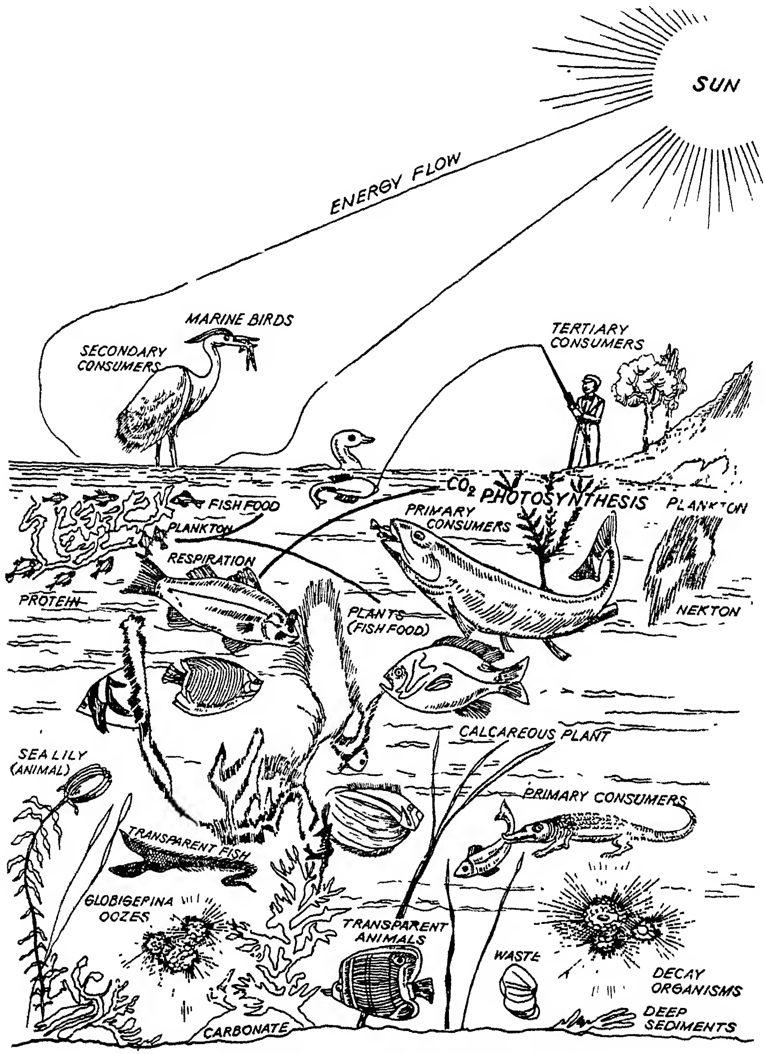

Fig. 14 2. Food Chain of Fish

Ecological conditions

Fishes occupy nearly every available aquatic habitat. The bound in the coldest seas and in Tropical oceans, in cold mountain lakes and streams, and in warm springs that reach a temperature high as 23°C. Many kinds live in the open seas, far from land, others

are found in the deepest depths of the ocean, in utter darkness. Fishes inhabit weeds, algae, rock crevices and hide under the stones. Some burrow in sand, gravel and mud.

In the Southern hemisphere the littoral fauna and flora are greatly restricted by the temperature, which is unfavourable to an abundant and varied life. To this is added the effect of ice, which transforms exposed coasts to marine deserts within the zone of ice attack. In the shallow waters offshore, where ice does not reach, there is abundant and varied life, and in the cold northern waters are many large animals which feed upon this life-dividing birds, seals, walrus and large fishes, such as cod, herring, halibut etc. Shallow banks in the cold north temperature waters and along the outer margin of the Arctic zone are the leading sources of food fish.

The great variety of life in the littoral zone is due to the variations in the environment—the variations in temperature exposure, nature of coast, salinity, oxygen supply, and food supply. Several of these factors also influence the abundance of life, but none more effectively than oxygen and food supply. The abundance of plankton is less in the open Atlantic than in the coastal seas, and less at the very surface than at a short depth below the surface, being most abundant in depths of from 15 to 80 metre. Besides minute organisms are many larger floating and swimming species, and some clinging and fixed forms attached to floating bodies such as logs and seaweeds, or to swimming animals. In the Sargasso Sea, for example, there is a miniature world of plant life and dependent swimming, crawling and fixed forms of animal life. Among the large animals are numerous fishes, some like the herring and mackerel, swimming in great depths, others moving singly like the shark and swordfish. The whale also roams in the surface and upper layers of the northern ocean.

In the Tropical zone the littoral fauna, in places favourably situated for food supply, is wonderfully varied and abundant. As upon the land, this abundance and variety can be ascribed in part to the warmth and the bright sunshine, which encourages plant growth, and consequently these are the great fishing regions of the world. Approximately three-quarters of the earth's surface is covered by water; but the great fishing grounds of the world are determined primarily by the depth of water upon them, and are almost entirely within the limit of a depth of 250 fathoms, and chiefly within 100 fathoms. It is improbable that any great abundance of fish is to be found far beyond these limits, and in any case the difficulty and the cost of fishing operations by the methods hitherto in use increase in proportion to the depth of water on the fishing grounds. Fig. 14·3 of the world with the area within 200 fathom line stippled showing the locations of the principal fishing grounds and the mean annual isotherms indicating the distribution of the kinds of fish. It is thus on what may be described as the shelves of

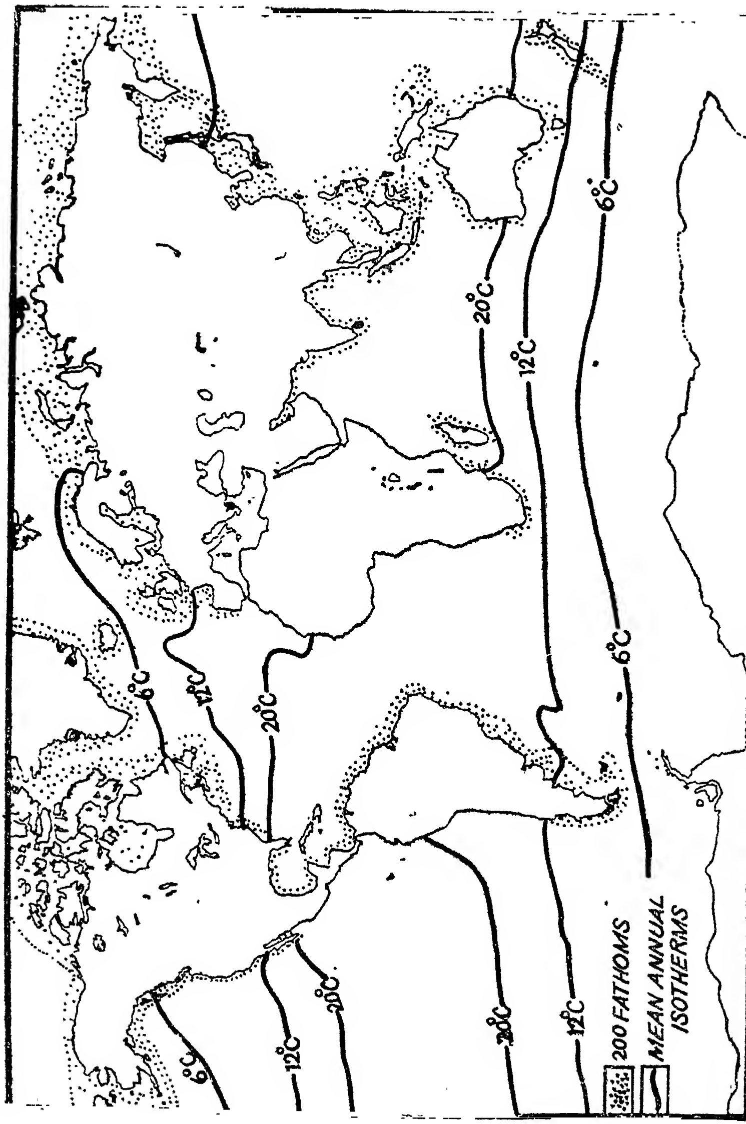

Fig. 14 3. Ecological conditions for fish growth.

the continents or the banks of the oceans that the deep sea fisheries, the chief commercial fisheries of the world, are prosecuted.

GEOGRAPHICAL DISTRIBUTION

Contrary to popular belief, the sea is not an unlimited reservoir of fish. Vast areas are aquatic deserts in which little fish life is found. Temperature, depth of water and currents, which control the quantity of available food and affect conditions for reproduction, limit the number of fish found in the various ocean areas throughout the world. The greatest concentrations are found in temperate areas. The fisheries in the cold and temperate waters of the northern hemisphere, with a yield equal to about 80% of the world total, produce an overwhelmingly great part of the world's fish supplies. Although fishing is done along all coastlines, in enclosed seas and in fresh water sources, the principal fishing grounds of the world are located on the planktonrich banks of the continental shelves. The chief sources of supply of fish are the coastal margins of the sea, river estuaries and backwaters for marine and estuarine fish and tanks, ponds, canals for fresh water fish.

Fishes occur in every large river and nearly every large lake throughout the world. Few bodies of water, are without fish fauna. Fishes, in general, are divided into : inland fisheries, estuarine or backwater fisheries and marine fisheries.

INLAND FISHERIES

Inland fisheries constitute fresh water fish from ponds, tanks rivers and canals etc. The extensive areas of various drainage basins are the main areas for inland fisheries. Inland fishes are grouped under *cat-fishes*, *Carps*, *Mullets*, *Prawns*, *Murrels*, *Eels*, *Herrings*, *anchoveta* etc. Though several kinds of edible fish are obtained from fresh water sources, only a fraction of the inland water area is devoted to planned pisciculture, which is shown in Fig. 14·4.

Fresh water fishes are distributed in all the continents and in the large islands. The true freshwater fishes are often divided into seven Zoo geographical regions :

1. **Nearctic**—Canada, United States and most of Mexico included in this region.

2. **Neotropical**—It includes central and South America.

3. **Palaearctic**—In this region includes Europe and Asia mostly Southward to the Himalayas and Yangtze river.

4. **Indian region**—includes India, Southeastern Asia, Java, Sumatra and Borneo.

5 **Ethiopean Region**—Whole of African Continent.

6. **Madagascar**—It includes the surrounding region of Madagascar in South-western Indian ocean.

7. **Australian region**—Australia, NewZealand, the islands of the Indo-Australian Archipelago east of Wallace's line running between Borneo and Celebes and the islands of Bali and Lombok.

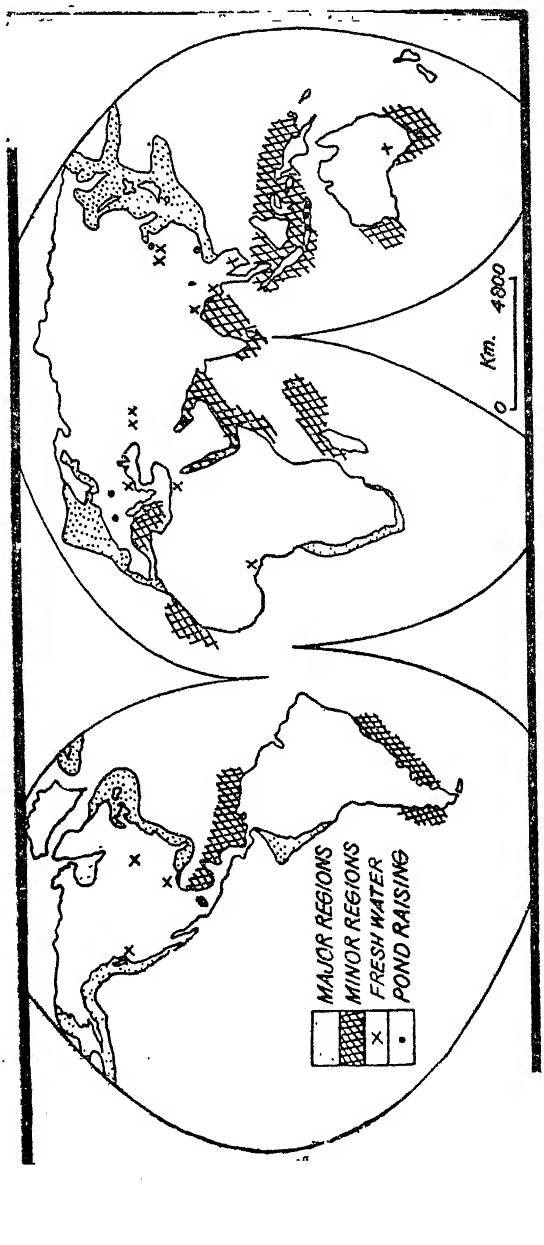

Fig. 14·4. Distribution of Major Types of Fisheries.

There is a greater resemblance among the true fresh water fishes of Europe, northern Asia, and North America than between those of North and South America, and between those of Africa and South America than between those of Eurasia and Africa.

BACK WATER FISHING

Most of the fish of the world live in the waters over the continental shelf the sub surface plateau which surrounds all continents or great land masses. The continental shelf is considered the plateau out to the point at which the bottom of the sea slopes below 200 fathoms (400 meters).

Back waters in Tamil Nadu, Kerala, deltaic regions of Sunderbans, and all the deltaic areas are the principal sources of estuarine and backwater fish. In India, the estuaries of Mahanadi and Ganga, stretching from Puri beach to Hooghly and extensive fishing grounds containing *Hilson, Pomfrets, prawns, Catla, rohu, Singada* etc. All the deltaic regions or big rivers of the world are the best example of estuarine fisheries.

SEA FISHING

At present sea fishing is carried on within 100 fathoms in the sea, and is confined mainly the coastal waters from the shore to continental shelf. It varies considerably in width, reaching in some places 160 kilometres or more from coast line. The further extension of this limit has been favoured by the fishermen whose livelihood is largely based on the resources of coastal waters where catches have been very unreliable in recent years because of the changing habits of fish due to changing biological conditions in the waters. Marine fishes, in general, are divided into coastal, oceanic and deep sea forms. Fig 14·5 shows the fertile areas of the oceans.

The fishing industry of Britain and Japan are highly organized in the world. The inland fisheries of Britain and Japan are of little commercial significance. The inland fisheries of many of the industrial nations have suffered from reckless pollution.

In deep sea fishing nation Great Britain is supreme, for no country has as great a fleet of powerful vessels equipped for distant voyages. The fishing fleet of Britain included 1,015 steam and 600 motor vessels of more than 50 gross tons, nearly all of the steam vessels were trawlers, and most of the motor vessels drifters or seiners. Comparative figures for the fleets of other European countries were : German Federal Republic 200 steam and 35 motor, France 60 steam and 1247 motor, the Netherlands 42 steam and 457 motor, and Norway 1699 steam and motor vessels. The sea fishing fleet of Denmark consisted of 1,336 vessels of more than 15 tons, most of them seiners and all motor driven. Fishery products provide the average Soviet citizen with one-third of hi total consumption of animal protein. Some reports place the

1. Helin, R A.—Soviet Fishing in the Barents Sea and the North Atlantic. Geographical Review, Vol. LIX, 1964. pp. 386.

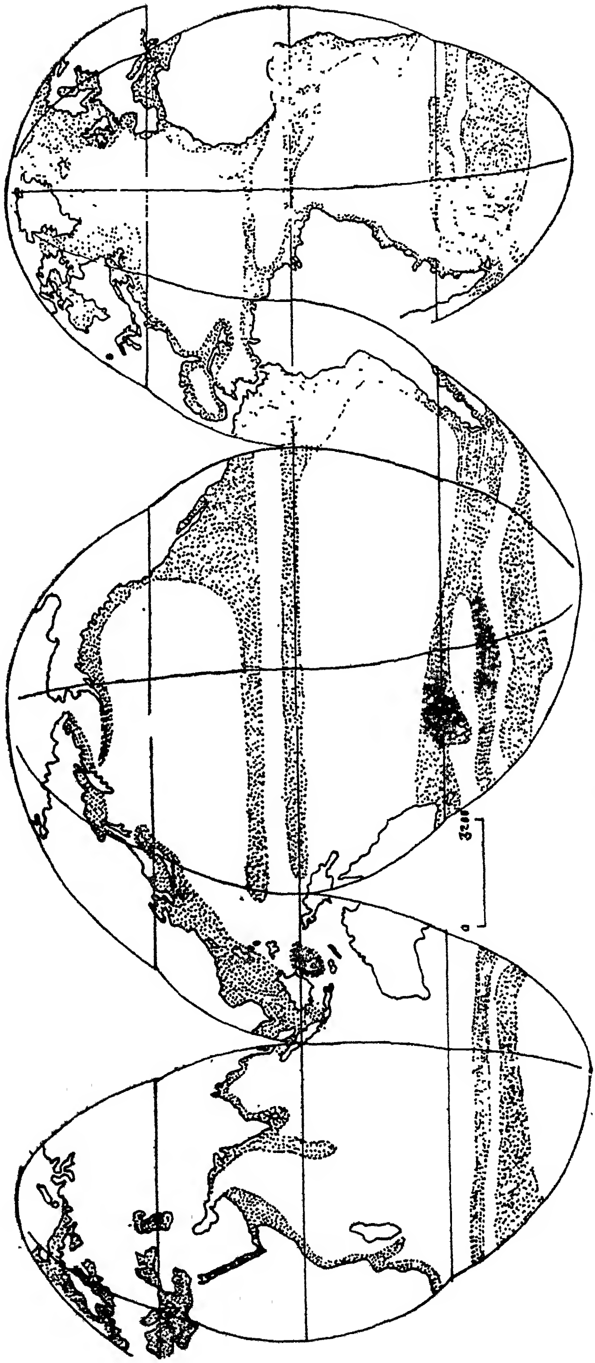

Fig. 14·5. Fertile areas of the Sea.

as high as 40 percent. "Today maritime waters contribute about three-quarters of the 3,250,000 ton annual catch, and national vessels regularly visit banks far from Soviet coasts. Significantly related to the successful exploitation of high-seas fisheries is the northern coast of European Russia."

MAJOR FISHING GROUNDS AND NATIONS

The world's most productive fisheries on commercial basis are found in the humid cold and shallow waters above the continental shelves of (*a*) north western Europe, (*b*) north-eastern north America (*c*) north western north America and (*d*) north eastern Asia.

North Western Europe

This region is also known North eastern Atlantic region. These fishing grounds include the Barents Sea, the Norwegian fiords and shallower parts of the Norwegian sea, the Skagerrack and Kattegat,

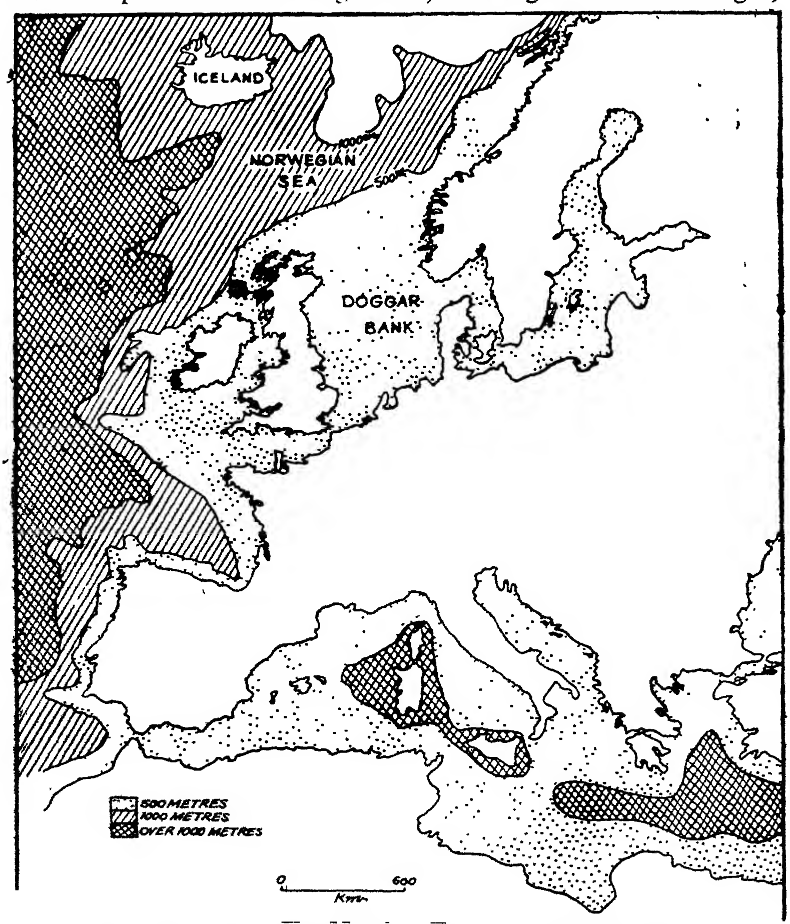

Fig. 14 6. Topography of North East North Atlantic ocean

the Baltic Sea, the gulfs of Finland and Bothnia, the north sea, the English channel and the Irish Sea. It is shallow, about 200 metres, and abounds in fishing banks, the Dogger Bank being the largest and world famous for commercial fishing. The topographic conditions of North Western Europe is given in Fig 14 6. The sea fisheries round the European-shores are very valuable, but river-fish, save *Salmon* and *trout*, chiefly caught in certain Scottish and Irish rivers, are not very important. The shallow waters round the Dogger Bank in the North Sea are particulay rich in *Cod* and in *flat*-fish, such as *plaice*, *sole*, *turbot* etc. The fiorded sea coasts from Stavanger to Hammerfest, a distance of over 1610 km. are noted for *Cod,mackerel*, *coal* fish, *white* fish and *prawns*. *Mackerel* are also widely distributed, while *pilchards* are chiefly found off the Cornish peninsula, and had dock off the east coast of Scotland.

Herring are caught all round the coast, for they migrate from the North, where they are found in summer, to the English Channel, where they appear in winter. Herring form about 65% of the catch. Oysters are mainly reared off the coasts of Kent and Essex.

The Barents sea is the chief fishing region of the Arctic Ocean fisheries of the Soviet Uuion. Herring and cod are the major part of the catch. The major fishinig ground is Murmansk. Murmansk has grown so much that it now occupies about 20 kilometres of shore on the eastern side of Kola inlet. The fish harbour commands about a kilometre and a quarter of piers on the eastern shore. "Fishing vessels docking in Murmansk land fish that is frozen into blocks, salted in barrels, or chilled on ice, cranes and mechanized unloading lines transfer the cargoes into dockside sorting houses. From there fish already finished at sea (about 20 percent of the catch) passes straight into storage warehouses or waiting rail road cars; salted herring and blocks of frozen cod and sea-perch fillets probably constitute the greater part of the transfer. Partly finished and unfinished fish passes into the Murmansk Fishery combine, an agglomeration of factories occupying about a hundred acres (or 40 hectares) along the Murmansk water front. Canned fish has yet to acquire large-scale importance in the Murmansk industrial scene."[1] Fishing is much more important to certain areas in Norway than others although Norwegians engage in commercial fishing to some degree along the entire western coastal waters about 2080 kilometres distance. The principal banks are off the west coast with latitude of Trondheimfjord separating the predominantly herring fishery to the south from the cod fishery to the north. At the same time, part of the catch of the Norwegian fisheries is derived from further a field, e.g. the Franz Josef Land and Spitsbergen areas. After Norway, Spain takes second place in terms of tonnage followed by Iceland, Great Britain, France, Germany and Portugal. Denmark, Sweden, Belgium and the Netherlands are other impor-

1. Ibid.

tant nations of western Europe but not in international market. Fig. 14·7 shows the important catch of North western European countries.

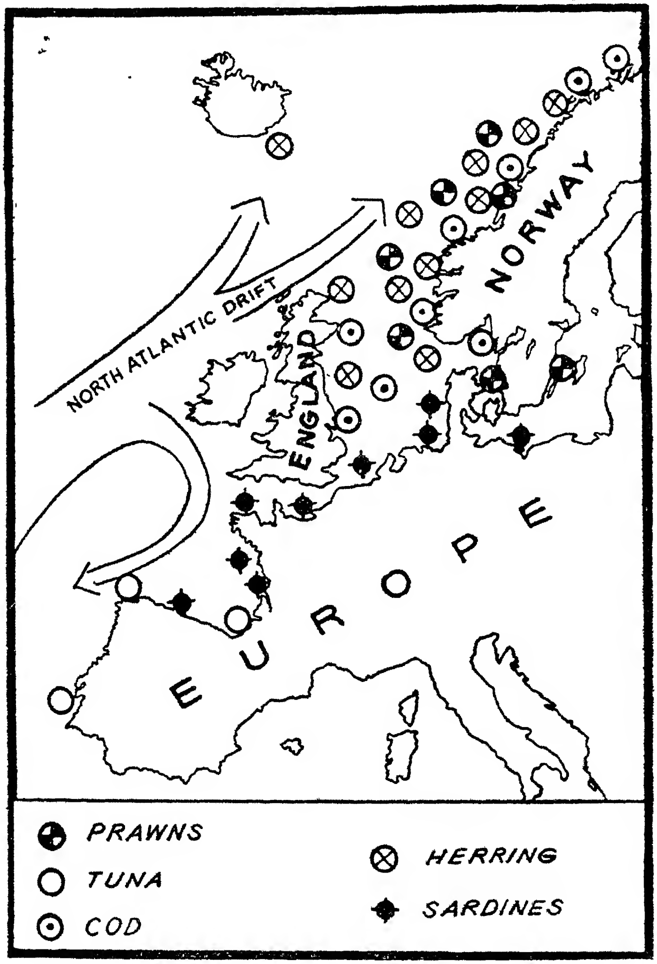

Fig 14·7. Important Fisheries of N. west Europe.

NORTH EASTERN NORTH AMERICA

The fishing banks extend along the coasts of New England estates and Eastern Canada from Nantucket Island to New found-land and into the Gulf of St. Lawrence, a distance of over 1760 kilometres. The region is also known as north-west Atlantic fishing region of the world. Ten banks are outstanding for their fisheries. They are (1) Grand Bank, (2) St. Pierre bank, (3) Canso bank (4) Banquerean bank (5) Stable island bank (6) LaHave bank

(7) Brown's bank (8) Georges bank (9) Middle bank nad (10) Jaffrey bank. These banks are shown in Fig. 14·8.

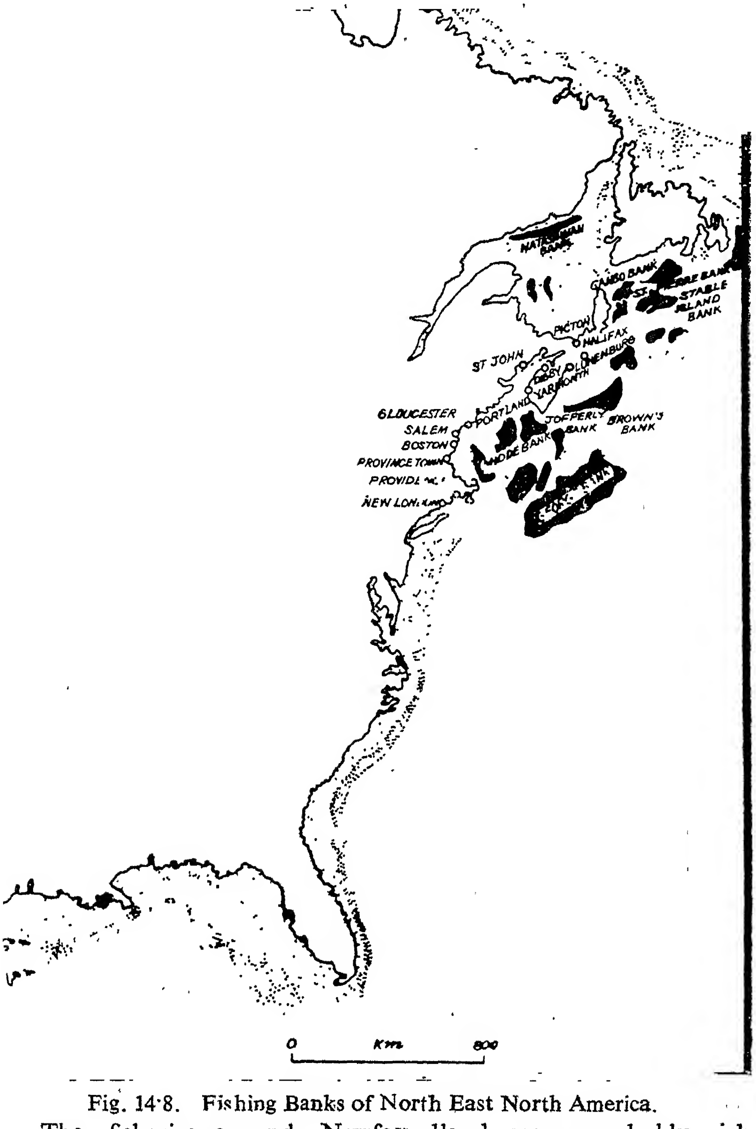

Fig. 14·8. Fishing Banks of North East North America.

The fisheries around Newfoundland are remarkably rich. They owe their existence to the slime brought hither by the cold Labrador current, which furnishes food for the fish, and to the ice-floes, on which in the spring seals rear their young. The seals are then an easy prey, and are killed on account of the oil they yield

and for their skins, though these are not the fur-bearing species. The waters most famous for fish are known as the Great Banks. Here *cod* and *Herring* are caught in large numbers, the season lasting from June to November, and both are salted and dried in the sun on the island on stages erected for the purpose. In Newfoundland about 90 percent of total population is engaged in fishing. Fishing and allied marine industries are an important sector of the economy of the Maritime Provinces of Canada especially in New Brunswick, Novascotia, Prince Edward Island. The region has a 8000 km. long coastline with a fishing area of 520,000 sq. km., centred at Grand Bank. About two thirds of the total fish tonnage landed in New England is handed by four well-established parts—Boston, Gloucester, New Bedford and Portland. St. John's, Halifax, Newfoundland and Lunenburg etc. are the chief fishing ports in Eastern Canada. Most of the fish caught by the fishermen of North eastern North America are sold in fresh or frozen form on the Canadian and American markets. Inshore fishing for shell fish and crustaceans is also important and serves a vast market in the urbanized north-east Canada and Megalopolis of North America.

In 1972, commercial fishery landings at United States ports by U.S. fishermen were 4 0 billion (thousand million) pounds valued at a record $ 703·6 million at the previous year. The quantity landed was 5 percent less than in 1971, but, because of higher exvessel prices, the value was 9 per cent greater than in 1971.

Landings of edible fishery products amounted to 2·3 billion pounds in 1972, down 4 percent from 1971. U.S. landings of fish for industrial or inedible uses declined 7 percent in 1972 as compared in 1971. Total U.S. landings were smaller in 1972 than in 1971 principally because of marked decreases in landings of *menhaden* and *salmon*. The 1972 salmon landings decreased 11 percent. Significant decreases occurred in other species including alewives, Atlantic cod, haddock, halibut, jack, mackerel, whiting, dungeness crabs and soft clams. Skip jack landings of 46·8 million pounds in 1972 represented a decrease of 59 percent compared with 1971, but total tuna landings of 377·6 million pounds at ports in the United States were 8 percent above 1971 because of increased landings of yellow fin tuna. Fig. 14·9 shows the distribution of important fisheries of N. Eastern North America.

In western central Atlantic Cuba's fishing plateform is very important—about 500 different species and varieties of edible fish live around the island. Cuba's catch has steadily increased day by day: one of the contributing factors to this success has been the acquisition of modern boats built with the latest technological skills, which have enabled the radius of operation to be extended beyond the insular plateform, and new techniques are being used which have led to considerable production increases only 21·9 thousand tons of fish were landed in 1958 as against 90·5 thousand tons in 1970.

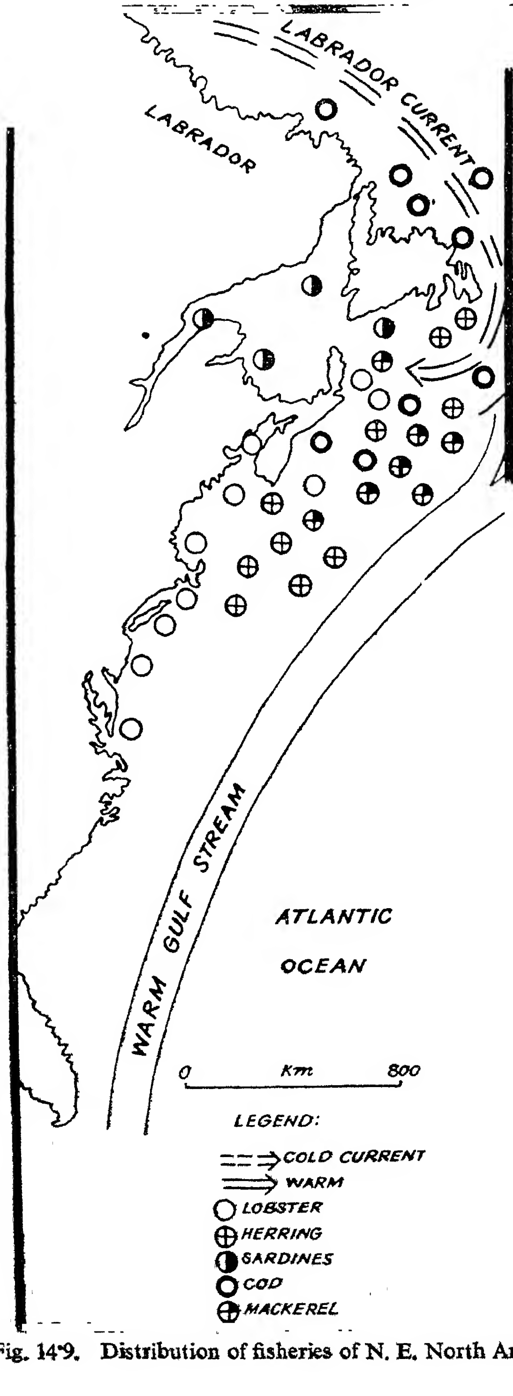

Fig. 14·9. Distribution of fisheries of N. E. North America

NORTH WEST NORTH AMERICA

The waters of north west north America comprise the greatest fishing region in the world. The fishing banks extend along the coasts of Alaska and western Canada from Kodiak Island to Vancouver and further South into the Gulf of California, a distance of over 4000 kilometres. British Columbia is by far the largest fishing state of north East Pacific fisheries. Along its highly irregular and indented coastline of about 11,000 km. and in some of the Pacific bound rivers such as the Fraser and Skeena, are many fish. This long and narrow fishing regions is best known for its *Salmon* and, *halibut*, but large numbers of *herring*, *sole*, *cod* and other fish are also caught. *Salmon* is the most important fish caught, it is mostly exported as canned salmon. The Salmon fisheries of Alaska located along 11,000 km. of coast line are one of the richest nartural resources of the North Pacific. Caught during their summer runs, the Salmon are largely processed in local canneries, the pack being valued at 70 to 90 million dollars annually. More than half of the world's halibut are caught between Cape Blanco, Oregon and Dutch harbour in the Aleutian Islands of Alaska, which is shown in fig. 14·10.

Quite recently it has been shown that a northern species can be transferred to the south and will flourish their if the right conditions prevail, for the North Pacific Salmon has been artificially transferred from the Canadian rivers to those of the South California—a particularly delicate ecological adjustment since conditions must be exactly right in both the fresh water rivers and in the Sea. Salmon, Halibut, Mackerel, Tuna, herring etc. are important species of this region. Large quantities of crabs, shrimps and oysters are also caught for the North American market. This region is also known as north western coastal region of North America.

Among the fish processing establishments in operation in Canada, *salmon* canneries comprise the principal group in British Columbia. There are, in addition, a large number of lobster and Sardine canneries and other establishments totalling 344 in 1970. The total number of persons employed in 1971 in primary operations was 58,845. Modern techniques especially refrigeration establishments have substantially increased.

THE NORTH EASTERN ASIATIC REGION

This region is also known as north west Pacific region of the world. The north eastern Asiatic region from the Bering sea to the East China sea is the world's greatest fishing area of the world. This region produces herring, haddock, bonito, Salmon, Sardines and tuna fish. In whaling, Japan is the world leader and accounts for about one third of the total whale oil production. Japan is the world's greatest fishing nation. The development and importance of the Japanese fishing industry are the results of many eco-social factors. These may be summarized as follows :

1. The important factor is that the existence of excellent

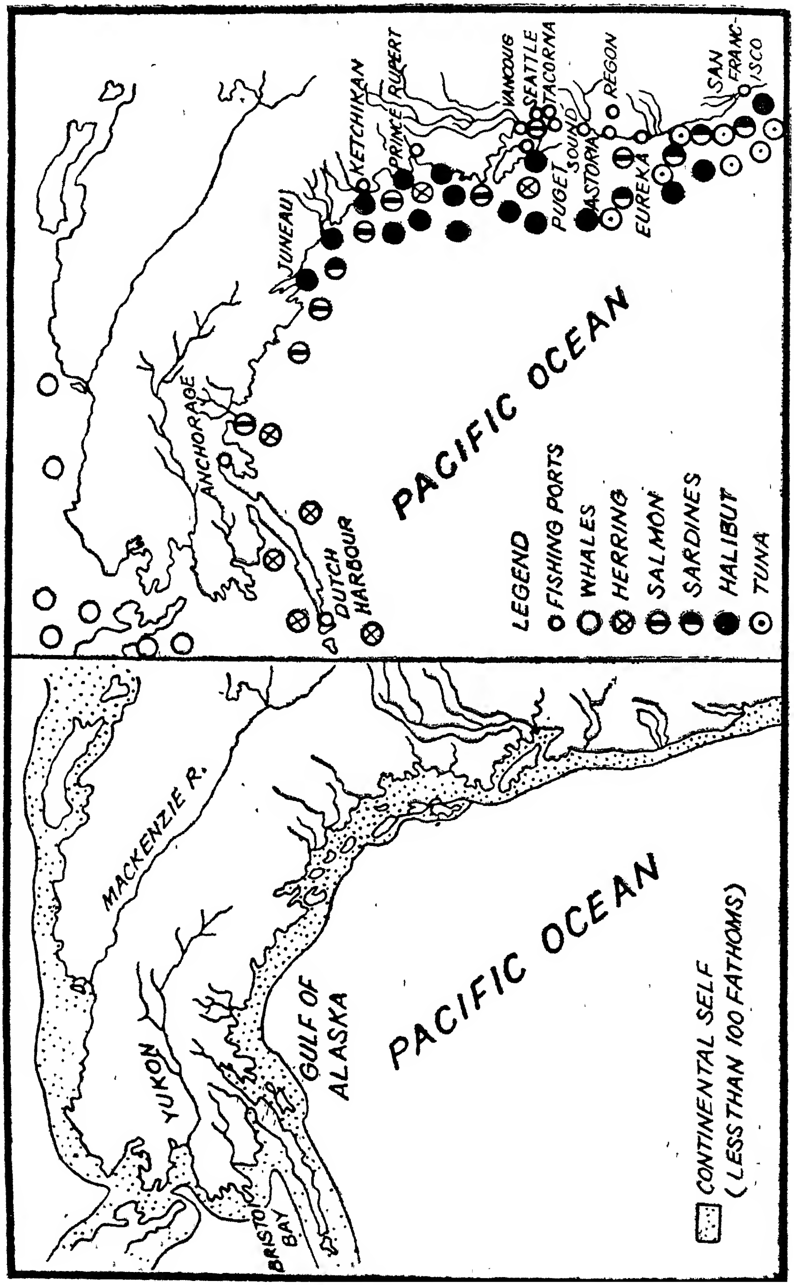

Fig. 14·10. Fishing belt and important fisheries of north-west-north America

fishing grounds in water off eastern Asia, where the converging warm and cold currents have attracted a great variety of marine life. The greatest zone of marked convergence and mixture of cold Kuriles and warm Kuroshio waters in the western Pacific ocean extends from about latitude 37° N. off the east coast of Japan north eastern towards the Kurile Islands. These are the most important fishing growth for Japanese in eastern part. Coastal fishing goes on throughout the year.

2. The Japanese people catch and eat more fish than any other people in the world. The bulk of the catch in the North west Pacific is made up of Salmon, from the Kuriles, Sakhalin and Kamchatka.

3. The peripheral concentration of the population on small plains fronting upon tide water.

4. The insular character of the country or its highly irregular and indented extra-ordinary length of coast lines.

5. Japan is a mountainous country with limited lowlands. The dense population in conjuction with the meager natural resources of the country, which has no doubt turned the population toward the sea. Fish have always been a major source of protein food, supplying 60% of animal proteins in the Japanese diet.

Japan is the foremost fishing country in the world. In pre-war days Japanese catch averaged about 4,300,000 tons, more than double the output of the U.S., the second most important fish-producing nation. In 1970, total catch was 9,314,662 million tons. Fish farming is important occupation of Japanese peoples.

Fishing is more important in Philippines. The waters of the Philippines teem with a great variety of edible fish. The fishing industry ranks next to farming and livestock-raising in point

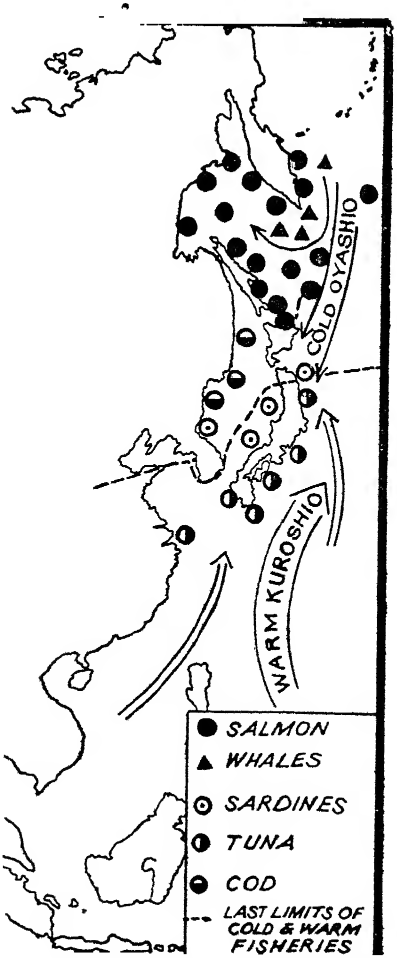

Fig. 14·11. Asiatic Fisheries

of value and the number of persons employed. Fish, after rice, is the main element in the Philippine diet. In 1971 a total of 1,085,900 metric tons of fish were caught, compared to 988,900 in 1970.

The fish resources of the Far East are enormous. However, they are far from being fully utilized. The remoteness of the fisheries from the consuming centres and the absence of local sources of salt are the main obstacles hindering their utilization. In recent years fishing has shown here a rapid growth. The principal fishing regions of the U.S.S.R. are : the coast of Kamchatka, especially its western part, the estuary of the Amur and the coastline of south Sakhalin. Herring and Salmon fish (Siberian and hump-backed Salmon) constitute the bulk of the catch. Fig. 14·11 shows the distribution of Asiatic Fisheries in North Western Pacific Ocean.

Fishing outside the major Regions

Outside the four main fishing regions of the northern hemisphere there is very little well-organized commercial fishing. Tropical waters, though exploited on a small scale for centuries, have less fishing potential because fish of commercial species are fewer. Outside the major fishing regions, India, Peru, Sri Lanka, New Zealand and Australia are important.

Peru is rich in fish. Since 1964, Peru has maintained its place as the first country in the world in the list of fish meal producers.

The Peruvian fish meal, of high protein content, is obtained from the anchovy. During 1971, 10·3 million metric tons of anchovies were caught yielding a production of close on 1,528,170 metric tons of fishmeal. The main buyers of Peruvian fish meal are the Federal Republic of Germany and the United States. The commercialization of fish meal is in the hands of the State under the organization called EPCHAP or Empresa Publica de commercialization de Harina y Aceite de Pescado.

Chile is the chief fishing country of South America. Very many varieties of edible fish are found along the sea coast, and there is an expanding fishing industry. The total catch of edible fish (including shell-fish) is now in the country of 1,000,000 metric tons per year. The whaling industry operates from two bases on the coast of Chile, where there are factories for treating the whales brought in.

Argentina is also important nation in fishing industry. The volume of fish caught in 1971 (including fresh water varieties and shell fish) amounted to 201,746 tons. The processing of fish was carried out by 196 establishments, which together produced, among other items, 15489 tons of fish preserves and 19,198 tons of fish meal.

Fish stocks in Australian waters, although varied in species, are small by comparision with the stocks of the Northern hemisphere. In 1971-72, 57,002 tons live weight of fish, 31,313 tons gross weight of crustaceans and 29,479 tons in-shell weight of

molluscs were taken. The main types of fish taken were : Juna, shark, mullet, Australian Salmon, Snock, Snapper, Morwong and Flathead. The main items of Australian imports of edible fisheries products during 1971–72 (valued in total at $ 41·4 million) were : fish–fresh and frozen, 22,223 tonnes; smoked, salted or dried 3,753 tonnes, canned or bottled, 11,468 tonnes; crustaceans and molluscs 3,687 tonnes. The total value of Australian exports of edible fisheries products during 1972–73 was $ 74 million. Rock lobster exports amounted to almost 50% of this amount.

Pearl and trochus shell are taken in the tropical waters off northern Australia, with catches of 479 tonnes of pearl shell and manufactured shell produced from pearl culture operations and 0·7 tonnes of trochus shell in 1971–72.

Whaling was restricted to one shore-based station in western Australia. In 1973, 953 whales were taken which produced 34,632 barrels of oil.

In Indonesia the catch of sea fish for the years 1972–73 was 802,000 tons and 824,000 tons respectively, that the fresh water fish was 447,000 tons and 402,000 tons respectively.

India produces about 0·89 million tons of marine fish out of the total fish production of 1·3 million tons, which is only a quarter of the countrys requirements estimated at about 4 million tons annually. The fishing industry in India offers employment to about a million persons and contributes annually over Rs. 60 crores towards national income. The production of fish during 1974–75 was 1950,000 tonnes as against 1850,000 tonnes in 1973–74. About two-thirds of the catch are marine fishes. Production is shown in table 14·3.

Table 14·3
Production of Fishes in India
(Figures in 000 tonnes)

Year	Marine	Inland	Total
1969–70	824	507	1331
1970–71	1030	600	1630
1971–72	1120	599	1719
1973–74	1230	620	1850
1974–75	—	—	1950

At present sea fishing is carried on within 10 fathoms in the sea and is confined mostly to the coastal states of India such as Gujarat, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal.

There is practically no fish-canning industry in India but curing is being carried on in various ways. In India fish is preserved by desiccation with or without salt and by the use of antiseptic preser-

vatives, such as brine, vinegar, etc. The main process is the desiccation by drying fish in the sun. It is also done by salt. Canning is practised on a limited scale in Tamil Nadu and Maharashtra. The cured fish has developed lucrative export trade with Sri Lanka and other countries. Fish curing yards have been established in many coastal states of India. In order to develop fish industry in India on a extensive scale refrigeration system has become absolutely necessary. Cold storage facilities are being developed in every part of the country.

In the FAO Surveys India has been included in the category of low fish consuming countries whose average per capita consumption falls below five kilograms. India's neighbour, Burma is among the fish consuming countries with an average of 20 kilograms per capita.

Approximately 92% of the total production in India is used for edible purposes and eight per cent for the manufacture of industrial and other products.

In India experiments in mechanization of fishing are being conducted since 1948 with the help and assistance received from Norway, U.S.A. and F.A.O. The FAO,TCM and Indo-Norwegian Foundation continued to give valuable technical assistance. Many harbour specialists continued work in connection with the development of fishing harbours in the states of Maharashtra, Kerala, Tamil Nadu, Karnataka and west Bengal under the expanded Technical Assistance Programme of F.A.O. Many Fisheries engineers worked on the Tamil Nadu, Kerala, Gujarat and Maharashtra coasts, on the introduction of new types of fishing gear, use of mechanized aids and the training of fishermen in their use. At present there are about 10 thousand mechanized fishing boats operating in India. With a view to augmenting exploratory fishing and fishing in distant waters it is proposed to acquire 2 large vessels of 35 m. length and to conduct 40 shrimp trawlers of 19 metre length. Besides, three large fishing vessels have been received from Norway under the Indo-Norwegian project.

To train persons in fishing trade and development the government has established Central Inland Fisheries Research Institute at Barrackpore. For sea fishing there is another centre at Mandapam camp known as Central Marine Fisheries Research Institute. Beside there are other stations which conduct exploratory surveys for charting new fishing grounds. There are at Bombay, Cochin, Tuticorin, Visakhapattanam and Mangalore. To evolve efficient mechanical devices two new stations have been set up at Cochin and Ernakulam. The Central Institute of Fisheries Education at Bombay imparts training in advanced fishing technology. Apart from that 10 new extension units and 14 fisheries units are working at various places. The states fisheries development and field staff of community development are also laying greater emphasis on trained personnel and efficient methods of fishing During the Fourth Plan schemes have been formulated to boost production

and quick disposal of fish and fish production. Measures have also been adopted to export a fair quantity of dried fish and fish product. The main objective of fishery programme in the 5th Plan is increased production so that adequate animal protein diet becomes available to the population and also sufficient fish for export trade.

WORLD CATCH OF FISH

Ninety seven percent or more of the world catch of fishery products is taken in the Northern hemisphere. Since most of the world's population is north of the equator, the fisheries of that hemisphere have been more fully developed than those South of Equator. As the need for supplies of fishery products increases, exploitation of the fishery resources of the southern hemisphere will be undertaken. Little is known of the extent of these fisheries, but it is believed that there are extensive populations of fish in a number of areas.

The fisheries of the Pacific and Atlantic oceans each yield about 47·5 percent of the total catch, while the Indian ocean supplies

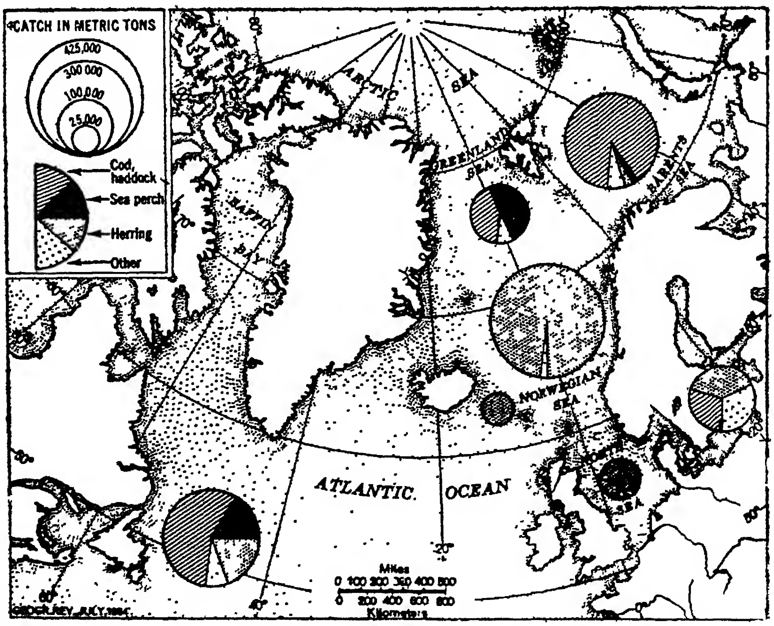

Fig. 14·12. Landings of fish from North Atlantic ocean.

most of the remaining 5 percent. Herring obtained from grounds in the eastern North Atlantic make up about three-fifths of this total ; the remainder consists largely of demersal fish especially cod, sea pearch and haddock etc. from banks off the Canadian coast. Fig. 14·12 shows the landings of fish from North Atlantic ocean. World catch of fish is given in table 14·4 :

Table 14·4
World Catch of Fish[1]

Country	World's percentage
Japan	14·6
China	11·5
U.S.S.R.	9·7
U.S.A. and Alaska	9·1
Norway	7·0
United Kingdom	4·2
Canada, Newfoundland and Labrador	3·7
India	2·9
W. Germany	2·6
Spain	2·3
France	1·8
Iceland	1·6
Union of South Africa	1·4
Other Countries	27·6
Total	**100·0**

The annual world production of fishery products totals about 57,0 0,000,000 lbs. Asia accounts for over 45% of the total, Europe about 3% and North America about 17%. Waters in other seas account for less than 5 percent of the total. Japan, with a annual catch of over 8.000,000.000 lbs., is the leading fishing nation of the world. The large population occupying the Japanese islands and the small land area available for farming, has forced the Japanese to look to the sea for the large part of their protein food supply. The Northern Pacific grounds are reputed to be one of the three best fishing regions in the world. The following table 14·5 shows the catch of some of the principal marine species in Japan.

Table 14·5
Catch of selected marine species[2]

(Figures in tons)

Species	Production
Herring	97,364[3]
Sardine	57,429
Horse Mackerel	270,870
Mackerel	1,253,892
Saury	190,288
Yellow Tail	106,845
Tuna	360,471

1. Year Book of Fisheries, F.A O and other Publications 1974.
2. World Fisheries Year Book and F.A.O. Publications etc.
3. Figures for 1971—72.

Salmon and Trout	
Halibut, Flounder etc.	
Cod	
Shark	
Sea Bream	
King Mackerel	19,870[3]

Fishing is more important in China, and the nation ranking second among the major fishing countries. Fish are utilized to supply certain parts of the country with animal protein. So densely populated is China that the country has turned to the sea as a partial compensation for the failure of the arable land. Pisciculture is well developed in China. Artificial methods of fish cultivation in China have chiefly proved useful where it has been desired to population streams or parts of streams which are understocked, or to introduce into a river a new species of fish. The Tuna, cod and Pacific bonito were by shad successfully naturalized in the rivers of China. Experiments carried out in certain Chinese rivers for the purpose of improving the native stock of cod and sardines by the introduction of fresh blood by crossing with the stock of other rivers by means of artificial fertilization of the eggs were inconclusive In the inland rivers and lakes, fishermen use all sorts of nets, traps and lines, including the use of fishing birds or cromorants to catch fish.

The U.S.S.A. is the third greatest fishing nation with an annual production of 5 million tons that is 9·7 percent of the world output. They make huge catches in the Arctic, off northern Norway and northern U.S.S.R., in the northeast Atlantic region; off eastern North America, in the Antarctic and even in the tropical waters of the Sunda shelf.

The United States with an annual catch of over 5,000,000.000 lbs. ranks fourth in volume of production among the nations of the world, after Japan, China and Soviet Union.

The value of fishery products processed in the United States from both domestic and imported raw materials set a new record in 1973—$2·3 billion, 23 percent above the previous record reached in 1972. The 1973 canned pack of human and animal food of 56·5 million standard cases valued at $ 89·3 million also set a new record. There also were record packs of tuna and clam products. Production of fish sticks and portions were a record 383·0 million pounds with a record value of $ 207·9 million, up 45·0 million pounds and $28·0 million from 1971.

Cold storage holdings reached a record high of 420 million pounds at the end of 1973. Imports of edible fishery products of 2·3 billion pounds valued at $1·2 billion were almost a third greater in quantity and 39 percent greater in value than in 1972 and established a new records.

In 1948—56 the United States was second only to Japan as a

producer of fishery products. Thereafter she declined in importance. In 1973, the latest year for which data are available on the world catch, the United States along with Alaska was in fourth place after Japan, China and U.S.S.R.

Norway ranks fifth among the nations in commercial fishing. The mountainous interior and limited land based resources have resulted in many Norwegians looking seaward for food and an economic livelihood throughout recorded history. The long, fjorded and island dotted coastline and the numerous offshore banks possess advantages for commercial fishing despite situated in northerly latitude far from equator. Fishing has always been one of the most important sources of income for Norway. The total number of persons engaged in fishing in 1973 was 39,757. A great deal of the fishing is seasonal and many of the fishermen have other occupations during the remainder of the year. The total yield of the fisheries in 1973 was 2,870,000 metric tons, with a value of 1·509 million kroner or 1·599 54 million rupees. During the nineteen sixties the whaling industry lost most of its importance, The herring meal and oil factories are especially hard hit in lean years as for example in 1961 when plants received 7,000 tons as compared to 700,000 tons during a similar time period in 1958-59.* on the Northern grounds there was no whaling during 1972–73.

In any evaluation of the fishing industry the Great Britain must take high rank. Today, on published data, Great Britain stands sixth among the major fishing nations. Fishing is more important to Scotlands economy than to England's. Scottish fishermen are among the most advanced in adoption of scientific equipment.

Canada, which ranks seventh in world fishing. Canada's fishing grounds fall naturally into three main divisions, Atlantic, fresh water and Pacific. The market value of sea-fisheries in 1971 was $ 436,569,000. Salmon is the most important fish caught. Pisciculture is well developed in western rivers.

*News of Norway. Vol. 18. No. 8, March 9. 1961.

CHAPTER 15

FOREST RESOURCES

Forest Resources constitute one of the most prominent geo-ecological features in the world. Forest resoruces are broadly restricted to parts of the earth where the winter season is not so long and cold as to make tree growth impossible. Within the zone of favourable temperatures, the occurrence of forests is sharply limited by precipitation, but the limiting amount is difficult to define since it varies with temperature and length of growing season.

By the second half of the 20th century, forests occupied 29% of the land area of the world; another 23% much of which was once forested was devoted to agriculture ; and 48% consisted of brushlands, deserts, mountain tops, towns and cities, roads, etc. The percentage of the world's forest area which occurred in each of the seven broad regions recognized by F.A.O. is shown in table 15·1, as is also the percentage of the total land area in each region occupied by forests.

Table 15·1
Regionwise distribution of forest resources[1]

Region	% of world forest area	% of region in forests
Europe	4	28
U.S.S.R.	19	34
North America	17	36
Latin America	23	40
Africa	21	27
Asia	14	20
Pacific Area	2	10
World	**100**	**29**

Latin America and Africa together accounted for 44% of the total forest area, the U.S S.R. and North America (Canada and the United States) for 36%, and Europe for only 4%. The forests of Latin America cover an area of about 890,000,000 hectares. The tropical forests are rich in oil-bearing plants, gums, resins, balsams, wax, essences, fibres and medicinal raw materials. South of the Equator there are vast areas of pine woods which constitute a valuable source of wealth, the standing timber being estimated at 400 million trees. The timber is of fine quality, and is exported under the name of Parana pine. The most valuable of the forest

1. FAO World Forest Resources, various publications.

trees is the Carnauba, an imposing palm growing along the river banks on the north-east, which supplies a wax in high demand for such varied applications as floor polishes, gramophone records, carbon paper and explosive. A number of factories extract tannin from native bark and wood. The quebracho, or axe-breaker tree, also yields a valuable dyestuff. 95% of Cocoa production comes from Brazil. The cinchona or quina tree, from which quinine is derived, does well in the South Other drugs such as strychnine, theo-bromine, atropire and curare are obtained from plants Within regions, Latin America, the U.S S.R. and North America were well above the average for the world as a whole.

Of the total 2:3 billion acres or ·92 billion hectares of land in the United States, 301·6 million hectares, or one-third is forested. The most recent timber survey indicated that of this forested area, 200,000,000 hectares are suitable and available for producing timber of commercial value on a sustained yield basis. There are more than 1,000 varieties of forest trees in the U.S.A., of which over 100 have commercial value. Species most used in the production of timber, plywood, and wood pulp include Douglas fir, ponderosa pine, southern pines, white pine, oak, hemlock, gum, maple, spruce and cypress. 69 percent of the wood is softwood.

More than 35 percent of the total land area of Canada is under forest. Spruce is the most important softwood. It is particularly valuable for pulb, owing to its light colour, freedom from resins and the characteristics of its fibres. Balsam and Douglas fir comes next in importance to spruce The Douglas fir is Canada's largest tree. Other softwoods are pine, cedar, hemlock and larch. Western red cedar (Jhuja Plicata) produces a particularly useful and durable timber, which is used extensively where durability and resistance to decay are important. Only 10 percent of the nation's deciduous trees or hardwoods, have commercial significance. Poplar is the most important hardwood. Birch and maple are used for veneers and plywood as well as for furniture and cabinet work etc.

The total area of U.S.S.R. covered by forests is 746,800,000 hectares,or 33 percent of the country's territory. About 70 percent of the timber supply is concentrated in the Northern and Eastern regions of the country, which abound in forests. There are big saw mills in Archangelsk, Leningrad, Volgograd, Astrakhan, Kremenchug, Igarka and other towns. In 1971 timber production was 298,600,000 cubic metres.

By the second half of the 20th century less than one half of the forest area of the world (47%) was accessible, and of the accessible areas less than two-thirds (63%) was in actual use. In other words, the world's entire production of wood for fuel and industrial use was coming from 30% of its forest areas. Table 15 2 shows the accessible and inaccessible forest resources of different regions.

Table 15·2
Accessible and inaccessible forest resources of the world
(Figures in hectares)

Region	Total 000,000 hec.	Accessible 000,000 hec.	% of total	In use 000,000 hec.	% of total	In accessible 000,000 hec.	% of total
Europe	136	133	98	130	96	3	2
U.S S.R.	743	425	57	350	47	318	43
N. America	656	312	48	220	34	344	52
L. America	890	329	37	83	9	561	63
Africa	801	284	35	108	13	517	65
Asia	525	311	59	232	44	214	41
Pacific Area	86	20	23	17	19	66	77
World	**3,837**	**1814**	**47**	**1,140**	**30**	**2023**	**53**

The above table shows that the U.S.S.R. had both the largest area of accessible forest and the largest area in use. Latin America had the largest total forest area, but only 37% of this area was accessible and only 9% in use In Europe 98% of the total forest area is accessible and 96% in actual use.

From the point of view of composition, the forest resources of the world are divided into two main divisions—*Conifers,* often called softwoods and *broad leaf* trees often called hardwoods. Fig 15·1 shows the distribution of various types of forest composition : The percentage of the total forest area in the various regions occupied by coniferous forests and broadleaf forests is shown in table 15·3. The preponderance of broadleaf forests in the world as

Table 15·3
Coniferous and Broadleaf forest Resources of the world
(all figures in hectares)

Region	Coniferous forests 000,000 hec.	% of region	% of world	Broadleaf forests 000,000 hec.	% of region	% of world
Europe	79	58	6	57	42	2
U.S.S.R.	580	78	45	163	22	6
N. America	463	71	36	193	29	8
L. America	27	3	2	863	97	34
Africa	3	N.A.	N.A.	798	100	31
Asia	120	23	10	405	77	16
Pacific Area	8	9	1	78	91	3
World	**1,280**	**33**	**100**	**2,557**	**67**	**100**

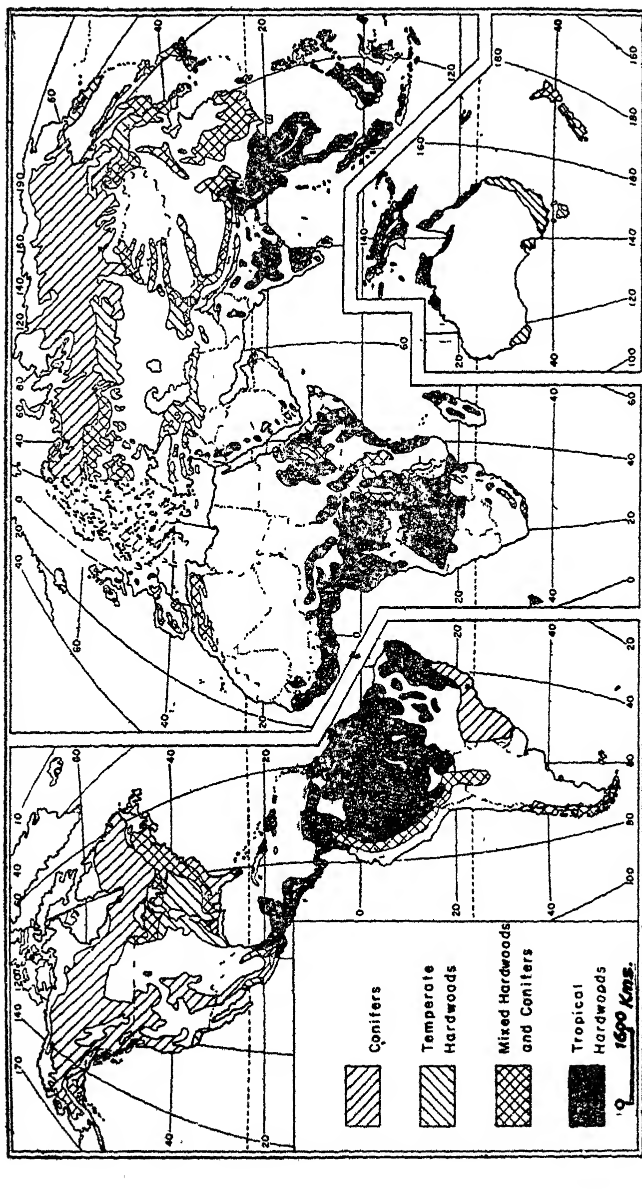

Fig. 15 1. Forest Areas of the world

a whole, and of coniferous forests in the northern hemisphere, is striking. Particularly notewarthy is the scarcity of coniferous forests in Latin America and their virtual absence in Africa. In spite of the fact that coniferous comprise only a third of the forests of the world, 53% of the forest resources in actual use consist of coniferous trees of Taiga.

MAN'S RELATION TO FOREST RESOURCES

The vegetation of the earth is complex, rich and variegated, over a great part of the world it is some kind of a forest. But continuous onslaughts by man, clearance, heavy exploitation and maltreatment by burning and over grazing have destroyed many climax forests and replaced them by scrub, Savannah, desert or large stretches of gullied, ravined or shoot eroded lands bearing neither field crop nor grass or trees.

The plants, animals and micro-organisms that live in an area and make up a biological community are interconnected by an intricate web of relationships, which includes the physical environment in which these organisms exist. These interdependent bio-physical components make up what scientists call as the "biotic complex" or generally known "ecosystem."[1] The relationships they discovered are illustrated in Fig 15·2. The ecosystem concept emphasizes the functional relationships among organisms and

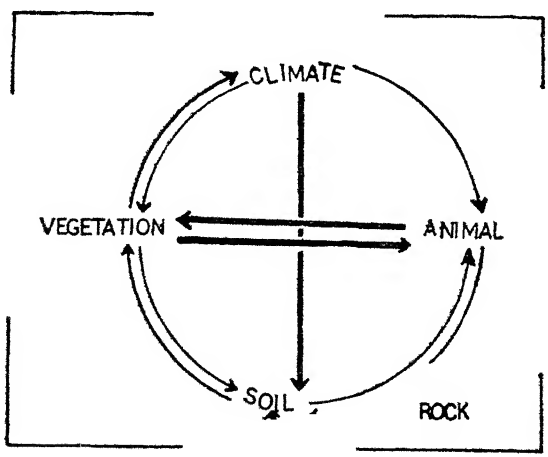

Fig. 15·2 Ecosystem.

betweeen organisms and their physical environments. These functional relationships are exemplified by the food chains through which energy flows in ecosystems, as well as by the pathways along which the chemical elements essential to life more through the ecosystem. Robert Mac Arthur eminent ecologist and authority

1. S. R Eyre—Vegetation and Soils, p. 4. Edward Arnold, 1968.

on "biotic complex" or ecosystem, suggested in 1955 that the stability of an ecosystem is a function of the number of links in the web of food chains. Mankind, according to Blache, "is a link in this chain. In his relations with his surroundings he is at once both active and passive, and it is not easy to determine in most instances to what extent he is the one or the other.........Man's activity influences not individuals, but groups, which have rights no less that he to be regarded as expressions of the environment. And so the conception of environment, which was formerly summed up in a far too simple formula, becomes more and more intricate as our knowledge of the living world increase. But the very complexity permits a lighter grasp upon it."[1]

Ecologists believe that this complexity is in part responsible for the stability of most ecosystems. Apparently, the more food chains there are in an ecosystem and the more cross-connecting links there are among them, the more chances there are for the ecosystem to compensate for changes imposed upon it.

Ecoioglsts believe that the organic life differs from the inorganic life in its need for food. Rocks do not require any food for the continuance of their existence on the earth; but sedimentation is essential for the development of rocks. Organic life, i.e. plants and animals; etc., on the other hand cannot continue their existence without food. The chief food that the organic life requires is carbon which gives heat and thus maintain life. The original source of carbon is the atmosphere. It is from the atmosphere directly that the plants and other forms of vegetable life take the carbon they require. The animals get their carbon from the vegetables and not directly from the atmosphere. Animals may also get the carbon they need from other animals which have taken it from the vegetable matter.

Water and oxygen are also needed by organic life for their continuance. These are also derived ultimately from the atmosphere.

When the organic life does not have the necessary amount of the food it requires or it cannot assimilate it due to some defects that have developed in its machinery, 'death' ensues. The form or the body of the organic life functions no more than in the way it used to function. It, therefore, disintegrates and the matter belonging originally to the atmosphere is returned to it. That is how the 'cycle of life' between the atmosphere and the organic forms is completed.

None of these forms of life are confined permanently to any one region or locality. They spread from one place to the other on the earth's surface. In the case of animals and man it is easy to see how they can spread from one area to the other. But in the case of plants, their seeds are carried by winds, water, birds or man from one region to the other. In this way,

1 Blache, Principles of Human Geog., P. 164, 1959.

even the plant life spreads. The seeds germinate in the new region, if the environmental condition is favourable.

Ecological factors for Plant Growth

Dirences in vegetation are of great imprtance to the geo-ecologist since no aspect of his environment is in closer relation to man, or has more control over his occupations and mode of livelihood.

The distribution of plant life over the earth's surface is determined by a number of ecological factors :—

1. The amount of heat
2. The amount and distribution of precipitation
3. The amount of light
4. The character of soil and rocks.
5. The nature and strength of winds.

It is necessary to understand the factors which control the distribution of vegetation. Heat, rainfall, snowfall light and wind are the main factors to which plant growth responds : soil has a secondary but mainly local influence It is owing to variations in the amount and seasonl distribution of the climatic factors that different kinds of vegetation occur, apart entirely from the component plant species of each formation.

Plants derive their nutriment from the air, generally by way of their leaves, and from the soil by means of water which their root hairs can absorb. Water and air are thus essential to all plant growth. Light is also essential, since it is only by the presence of light that the green matter of the leaves can turn the raw materials absorbed by leaves and roots in to the food on which the living substance grows. Light is the chief factor whereby plant manufactures its food (Sugar) from the green material in the leaves.

The ecologists lay great stress upon climatic factors. Any plant or any community at any part of the earth's surface must show a certain direct adjustment to the climatic factors. According to Newbigin, "climatic factors, of course, vary in character both from place to place and from season to season within the same place, and have the most direct influence in determining the distribution of the great plant communities. Broadly speaking, indeed, the major communities recognized are the organic response to those periodical changes in the duration and intensity of sunlight, temperature and rainfall conditions. which are themselves determined by the movements of the earth and modified by the distribution of land and water and the relief of the land surfaces."[1]

Of these, "the temperature would appear to play the dominant part. It is, for this reason, that, generally speaking, the main vegetation belts of the earth have a latitudinal or horizontal distribution."

1. Marion I. Newbigin, Plant and Animal Geography, p. 40, 1968.

Next in importance to temperature in the amount and the seasonal distribution of precipitation, either in the form of rain or snow. In regions of equal temperature, forests will, in general, occupy the areas of highest precipitation, deserts the areas of lowest precipitation and grasslands the areas of intermediate precipitation.

Apart from the function of winds in helping the plants in transpiration, their baneful effect on tree-growth is wellknown. Prof. Brockman[1] has pointed out that the actual tree limit is depressed in the regions possessing an oceanic climate, where naturally the velocity of winds is great. The tree limit attains it maximum polar extension in the continental area. In Siberia, for instance, the tree limit attains 72° 40′ N latitude, whilst in the Aleutian Islands it only attains 50°N.

The ecologist calls the influences exerted by the environment habitat factors, and the most obvious of these are due to geolgoy and soil. Geology and soil conditions have a powerful effect on forest distribution of the globle. Dr. G. Puri showed that rocks and soils offer media in which roots grow and plants draw nourishment for their growth. The structure of the formation and lithological and chemical composition of rocks are important factors for plant growth. The effect of the underlying rock on the distribution of forest communities has been appreciated by Dr. Puri, who found that the "underlying rock governs the growth and distribution of vegetation at the surface in two ways—

(1) by presence or absence of mineral elements, and

(2) by structural variations in the body of the rock, viz. dip versus scarp slope."[2]

In 1890 Mr. Middlemiss,[3] an English born Indian geologist showed the relationship between geology and plant growth as follows :

"The northern limit of the Tertiary zone is practically the limit of Sal tree, and, therefore of the reserved forests of this region. This geological boundary is very important and marked one and seems to have a real and direct effect on the prevailing forest species." Continues Middlemiss, "the Middle Siwalik sand rock generally forms low undulating country towards the plains supports a miscellaneous jungle." Middlemiss goes on to say that whenever the dip of strata is low, 10° to 30° and down Hill, the *Sal* tree has flourished far above any other tree."

The moisture supply to the roots of the plant is determined by the texture of the soil. The efficiency of a particular rainfall may be greatly influenced by soil structure. So, too, the facility for percolation in hot climates greatly modifies the effect of rainfall.

1. Geog. distribution of Plants, Geog. Jour—1926.

2 Physical geology and Forest Distribution, Secience & Culture, 15, .p 183–186, 1949.

3. Middlemiss, C. S.—Mem. G.S.I. 1890, Vol. XXV, Part 3.

Besides regulating the supply of moisture for the plant, the soil also determines the main part of its food supply.

Soils vary much in their composition and fertility, and also in their resistance to the percolation of water A coarse or sandy soil allows water to drain away quickly. The soil in limestone regions dries quicker as the water soaks into the rock. Clayey soils, such as loams and marls, being more retentive of water, are generally more fertile. But soils and subsoils which are practically impervious cause swamps with their characteristic vegetation. The most fertile soils as a rule are those composed of fine-grained river swept waste. Such alluvial soils owe their fertility to their fine division, varied composition and the presence of a greater or less amount of organic matter.

ECOLOGICAL STATUS AS A BASIS FOR VEGETATION CLASSIFICATION

We shall here deal only with the most elementary stages, in which it is unnecessary to give precision to conditions of temperature or rainfall by stating numerical values, or to conditions of vegetation by specifying individual plants or groups of plants.

For it is found that wherever the relation between temperature and rainfall is such that moisture is always or nearly always available in the soil, the natural vegetation is of the kind in which the plants grow on from year to year. The representative form of this is the tree, and these regions are distinguished by natural forest growth. Where the relation is such that during some part of the year moisture is so deficient that plant growth, or rather plant existence, is impossible, then during the moisture period the plants germinate, get through all the processes necessary for producing a seed which will retain its dormant vitality under great extremes, and themselves die when the conditions become insupportable. Thus the life cycle of vegetation starts a fresh every year, of which by far the most important representatives are to be found among the grasses.

We therefore obtain the first main division of the land surface into forest regions and grass regions But we note again that the question is not one of the absolute temperature or amount of rainfall, but of the relation of one to the other. The higher the temperature the more moisture is necessary for the growth of certain plants, and the lower the temperature the less the supply of moisture required—because evaporation is less–until a degree of cold is reached which stops vegetation altogether. Hence there are two types of region with no vegetation at all : the dry desert, which has too little moisture in relation to the temperature ; and the cold desert, in which there may or may not be plenty of moisture, but the temperature is too low for plants of any kind to flourish.

It is to be expected that the change from one set of conditions

to another will in general take place slowly, forest regions merging into grass regions and grass regions into desert.

Broadly speaking, two kinds of vegetation can be recognized, woodland and grassland : the absence of both is termed desert. Woodland varies in nature from the rich tropical forests to the far northern pine woods, and grassland may show every grade from luxuriant meadow land to semi-barren steppes.

THE HIERARCHY OF CLIMATIC CLIMAX COMMUNITIES

On the basis of the above mentioned points, it is convenient to divide the climatic climax vegetation of the earth into three classes–forest, grass lands and desert. Each of these can then be subdivided according to differences in detail in the form and functions of its dominant plants.

FORESTS

Forests grow in area of abundant precipitation. They can maintain themselves even in areas of relatively low rainfall, provided this is distributed with sufficient uniformity. In considering the availability of moisture to the plants, the nature of soil and the amount of transpiration must also be taken into account. Fig. 15·3 shows the distribution of forest resources.

CHARACTERISTICS OF THE MAJOR FOREST TYPES

Tropical Rain Forest

This is often referred to as 'equatorial forest'. The largest areas of tropical forest are the normal and modified equatorial belts of Africa and South America and those parts of the Asiatic monsoon area which receive rain from south west monsoon or from North East Anticyclone, retains enough moisture to maintain luxuriant vegetation throughout the year. It has the following major characteristics :

1. The characteristic of the vegetation is its rank abundance;
2. The forest is almost impenetrable,
3. The trees being interlaced with climbing plants of all kinds.
4. Since seasonal changes are scarcely noticeable, there are no special times of flowering, fruiting or seeding.
5. Plants, and even parts of plants, rest when it seems good to them, while others are in one or another of the different stages of vegetative activity.

No civilization having grown up in those regions. The most valuable economic products in such regions are coffee and tea. Coffe requires a higher temperature than tea, and can withstand only a very small amount of frost, the largest area available for its production is the coastal slope of Brazil, Colombia, Ethiopia etc. Tea is more of a sub-tropical plant, and is not injured by a certain amount of frost, it is largely grown in Southern China, Assam and Ceylon.

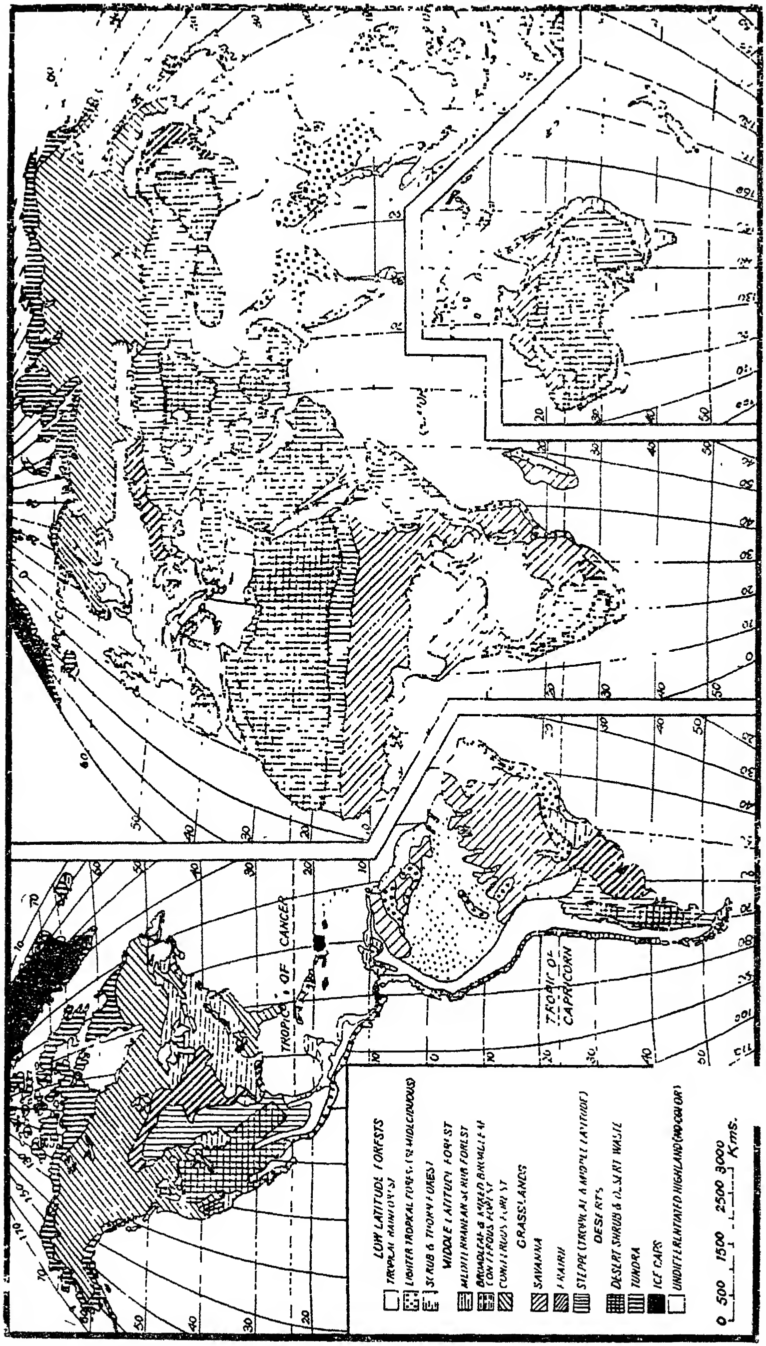

Fig 15·3. Distribution of Forest Resources

Teak has advantages for ship building and some other special purposes, but all the others appear to be either so soft and spongy as to be useless, or so hard and heavy as to be unworkable except for ornamental purposes. The most important are some of the many kinds yielding rubber, notably the *Hevea brasiliensis*, from which Para of Brazil rubber is obtained.

Sub-Tropical Forests

In the northern hemisphere much of this broad-leaved forest was of the deciduous forest with representative formations in monsoon Asia, Central America and Europe. Here the broad-leaved forests are almost entirely deciduous Among the most important, economically, of the plants found in these forests are the various coffee and rubber trees; and trees yielding valuable timber—such as aguru, Sal, Salin wood, Acacia catechu, Madhuca indica, hemlock, oaks etc.

Mediterranean Forests

Over the Mediterranean region a special type of vegetation prevails, which is suited to a dry, hot summer, and includes trees and shrubs which are generally evergreen and small-leaved, that is what they call as evergreen shrubs. The same type of vegetation is found in the California valley, middle Chile, the Cape area, and Southern Australia, where the climatic conditions are similar. Lacking the plentiful rainfall necessary for abundant tree growth, it forms a transition between the tropical desert-flora and the forests of the warm temperate regions. On the desert border is found the acacia type of vegetation, and it is this half desert which yields the most valuable gums and resins used in perfumery. Grapes, oranges, figs and olives are typical products of the Mediterranean climate, and similar conditions in California, Southern Australia and Cape colony make these countries also important centres of the wine industry.

Cotton is an important crop of this zone. It thrives best in a deep, rich soil with a long, hot season, the temperature is low during the period of greatest growth, but becoming drier during the ripening of the crop. Maize also grows most successfully in a climate of this type.

The Temperate Forests

A great belt of forests occupies the cooler latitudes of the North temperate zone, consisting of coniferous trees in the North and on the upper slopes of mountains, and of deciduous trees farther south. The trees of these regions are therefore deciduous, shedding their leaves annually before winter so that they are known as temperate Deciduous forests or warm temperate belt or Mesophytic forests. In the warmer temperate regions and on lowlands, most of the trees are of the mesophytic type, having broad leaves, which give off water vapour freely whenever they are exposed to light Typical examples are mapule, oak, elm, ash, beech Bhojpattra (Betula utilis), fig, silk-cotton tree, etc.

Trees, the leaves of which are specially adapted to restrict transpiration, however, can retain their foliage safely through the winter of the cooler temperate regions and at elevations where most of the broad-leaved trees have failed to obtain a footing.

The only regions in the southern hemisphere which come under temperate forest conditions are the narrow western slopes of southern Chile and southern New Zealand. This is the belt of temperate mixed forests.

The polar limit of the temperate forest is determined by temperature. As their is practically no land, the southern hemisphere does not come into consideration, only a few islands stud the otherwise unbroken belt of the Great southern ocean, and in them the weather is to stormy for tree growth. The coast of the Antarctic continent is within the zone of the cold desert far beyond the reach of vegetation.

Coniferous Forests

The coniferous forest, properly so called, probably formed a complete ring round the northern continents north of the regions of sub-tropical forest and temperate steppe. On the western sides of the continents the trees were probably always mostly coniferous, but as the climate becomes more continental eastward, deciduous trees occupy a belt on the side next the steppe, and the coniferous trees keep to the north.

Xerophytic trees mostly belong to this group, which includes the pines, firs, spruces, larches, cedars, cypresses, junipers, etc. Their leaves are more or less needle-shaped and leathery, with breathing-pores sunk below the surface. Larches, however, are deciduous.

In Scandinavia they consist chiefly of the Scotch pine, in Russia of a fir, in Asia of the Siberian larch and—further east-a species of pine. In America, spruce and pine to the west, and the American larch to the east, of the Rocky Mountains, are the commonest representatives of this hardy family. The conifers also abound in the Himalayas. It is significant that in both the old and the New world the larch thus replaces the pines and firs in the more continental climates.

Arctic vegetation

In the northern hemisphere the forest becomes gradually sparser and more stunted, and the characteristic flora of the Tundra takes its place.

In the Tundra the ground is forzen, except that in summer than penetrates for a foot or two below the surface, frozen the soil with ice-cold water. Only the lowliest forms of plant life survive under such conditions, and of these only the reindeer moss, and in the more favoured spots a few berries, are of even local value. The Tundra covers a stretch of varying width from northern Sweden to Bering Strait, and along the northern coast of Alaska through the

"Barren lands" of North America and the Arctic archipelago. On account of its great elevation, Greenland is mostly covered with ice and snow all the year round, the cold desert comes down into quite low latitudes.

GRASSLANDS

According to White and Renner that one-third of the earth's land surface is or was originally covered with grass. Grassland formations are normally the result of semiaridity, or of an extremely short growing season, or both. Where the availability of moisture is small, the prevailing type of vegetation is grass.[1] The grassland vegetation is subdivided on the basis of moisture and on the density of plants growth into the following types :

1. **The Tropical Grassland**—Savannas, llanos, campos and Downs of Southern hemisphere.

2. **The temperate Grasslands**—Steppes and Prairies of northern hemisphere.

THE TROPICAL GRASSLANDS

Intervening between the tropical forests and the dry deserts of the trade-wind belts, occur stretches of warm country with a moderate rainfall only. Here there are very few trees but grasses of various kinds which afford abundant food to herds of grazing animals Such Savannas include the African Sudan, the Venezuelan 'Llanos' of the Orinoco, the Brazilian Campos' or Selvas of Amazon, and the Australian 'Downs'. In the better watered portions some amount of agriculture is possible.

Here we find a great seasonal variation of rainfall, although the variation of temperature is comparatively small. Trees become scarcer as the distance from the tropical forest increases, and the type changes to forms able to with-stand long drought. In the moister regions grasses are heavy and grow to a great height, and with the woods produce the dense forest which is the congenial haunt of the larger animals, to whom the almost impenetrable equatorial or monsoon forest is somewhat inconvenient.

It has been found convenient by some ecologists to divide savannas into three categories on the basis of the grass cover that they support. They are ;

1. **The High Grass-low tree Savana**—In occurs extensively only in Africa The high grass-low tree Savanna occupies two main belts ; the first extend eastwards from Portuguese Guinea and Sierra Leone across northern Ghana, central Nigeria, the northern Congo and Southern Sudan to Uganda and the Second one across the South-western Congo and northern Angola.[2] According to Eyre "The most luxuriant type of Savanna has been referred to as high grass-low tree Savanna. The name 'elephant grass Savanna' has also been used since the elephant grasses *(Pennisetum Spp.)*

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1. R N. Dubey and L.R. Singh—Eco and Comm. Geog., 1964, p. 59.
2. S. R. Eyre—Vegetation and Soils, 1968, pp 239–240.

are common dominants ; they are nearly always mixed with other tussock grasses, however, belonging primarily to the genera *Andropogon*, *Imperata* and *Hyparrhenia*. These grasses are never less than five or six feet high at the end of the growing season, indeed they commonly form a dense jungle ten or twelve feet in height. The trees in the elephant grass Savanna are predominently deciduous and no more than thirty or forty feet in height but where they occur in larger groves, beneath which the growth of grasses is somewhat suppressed, greater heights may be achieved and evergreen species, typical of the Africa "Semi-evergreen" or 'dry' forests, often appear".[1]

2. The Second type has been referred to in Africa as acacia—Toll grass Savanna, but locally known by variotis local names, such as 'Llanos' of the Orinoco basin, campos of Brazil etc. The chief representative areas of this type being Kenya, eastern Tanzania, Mozambique, Rhodesia and a continuous belt from Gambia and Senegal eastwards across northern Neigria to central and South-eastern Sudan. According to Eyre, "the dominant plant again are tussock grasses which form an almost continuous cover over the ground even beneath the trees. At the height of the growing season the grasses attain a height of two to five feet. The trees may be either deciduous or evergreen. Deciduous species of *Acacia* and *Combretum* are commonest in Africa, evergreen *Eucalyptus* in Australia and species from a great range of families in South America." A good example of such tall grass Savanna is to be seen on the Nilgiri hills in South India.

3. Acacia desert grass Savanna—Here deciduous species of Acacia predominate over other woody plants that is why it is known as Acacia desert grass Savanna or "orchard steppe." Between forest and grass the tree growth becomes more and more sparse and irregular, the grass is rank and heavy, and as the dry desert is approached the grasses become lighter and thinner. Many plants of specialized form occur in such regions—the *Aristida*, *Adansonia digitata* with stand drought by storing up water, or minimizing loss by evaporation by reducing their leaf surface, while other plants send roots deep down into the ground in search of moisture. Along the margins of deserts, small thorny trees and bushes grow in raw dry climate. This third type of Savanna is characterised by a discontinuous cover of highly Xerophilous desert grasses along with a scattering of small thorny trees.

THE TEMPERATE GRASSLANDS

In the temperate zones—usually to the leeward of the forest regions, so that they receive a smaller rainfall and experience more continental conditions generally-occur extensive tracts of unwooded land covered chiefly by grasses and in the warmer months bright with flowers. These constitute the Steppe lands of the old world and the prairies of North America.

1. Op. cit

Plant growth begins as soon as the rainy season sets in, the ground is presently covered with a rich carpet of flowers, but as the heat increases and drought ensues, the grasses wither and diedown, leaving a crop of natural hay and distributing seeds which are indifferent alike to the heat and to the cold which may follow, and remain dormant till rain fall agains.

The moisture part of natural grass region supports the heavier grasses, and we meet the outposts of the temperate forest belts, the breadth of the transition zone again depending largely on the configuration of the land.

The dominant grasses mostly grew to a height of one or two metres during the summer season. They were a mixture of sward-forming grasses like *Agropyron smithii*, *Andropogon scoparius* and *Bouteloua curtipendula* and bunch grasses like *Sporobolos asper* and the common stipa graes *(Stipa Spartea)*. The commonest grasses are *stipa comata*, *Sporobolos cryptandrus*, *Agropyron smithii* and *Koeleria cristata* etc.

Directly or indirectly (as the food of animals whose flesh is used as meet), the grasses form the chief food supply of the human race. We must, however, recognize them as amongst the most important of the undeveloped regions of the world, for not only are large areas available for cultivation of food products which have hither--to been chiefly confined to the temperate steppe, but in many places, as parts of Africa, there is high summer temperature associated with moderate rainfall in the manner which is favourable to the cultivation of cotton and maize. The plants known as cereals are grasses with edible seeds, and it is. naturally, to the steppe regions that we must look for the principal sources of this all important food-supply. According to Ward[1] the great cereal lands of the world are found in the continental interiors in the regions of summer rains, where the precipitation is sufficient. Roughly, between latitudes 40° and 52°, other conditions being favourable, we find the principal wheat belt, but wheat is cultivated much farther north, for example in Asia, and also farther south than the above limits. Barley grows over a much wider belt, both poleward and equator-ward; oats grow north of wheat and corn grows south of it. In the higher latitudes, with shorter summers, it is more and more difficult for cereals to ripen. It is worth noting, that the wheat harvest in Argentina usually begins late in November in the north, and progresses southward until February, in India the havest begins late in February in the south, and progresses northward until early in May.

DESERT VEGETATION

More than half of the land lying in the trade-wind belts consists of desert. It is in such situations, naturally, that the scanty vegetation which can exist at all will show most markedly Xerophytic characters. Along the margins of the deserts, where the

1., Ward—Climate, pp. 507–510.

rainfall is slightly more abundant, thorny plants—Principally *acacias*, *cereus giganteus*, *Equisetum arvense*, *casuarina stricta*, *Casuarina*, *Acanthosicyos horrida*, *Citrullus colocynthis*, etc. are common. This group *(acacias)* has been said to constitute an "acacia-fringe" round all the great trade wind deserts of the world, In desert area, where much bare ground is normally apparent, wind speed, humidity and even temperature near the ground are different from what they would be were there no plant cover. In this environment a plant can be regarded as being in direct relationship with its ecological conditions where as, elsewhere, plants grow so close together as to modify the environment for each other.

The vegetation can be divided into two classes :

1. That which is dependent solely on the occasional showers that occur, and has, therefore, a very brief existence;

2. That which depends mainly on subterranean water, and is perennial. To the first class belong the grass and even delicate flowers which some times spring up in a wonderfully short time after rain, and as quickly wither away. To the second class belong the trees, shrubs, and plants which, even in a more marked degree than those of adjoining regions, are adapted to withstand drought. Most have deep roots—i.e. the acacias, mimosas and temarisks, which often occur along the wadis, where moisture lingers longest; others have succutent and thorny stems and leaves. Some of the trees yield gums, and some of the plants can be eaten by the hard mouthed camel, but many have no economic value.

In the oases and on the margins of rivers flourishes the invaluable date-palm. More typical of the inner desert are cacti, various very fleshy species of Euphorbia (allied to the spurges) which assume the most weird shapes, the "ice-plant", and the grasses called esparto or halfa. Many of the desert plants are covered with thick flannel-like coasts of hair to prevent loss of moisture.

When the rare showers of rain fall in these deserts a host of small herbaceous plants, bearing brilliant flowers, springs up, A few days suffice for germination, flowering and the production of the seeds, bulb or tubes, necessary to complete the cycle at the next opportunity.

ECOLOGICAL ADJUSTMENT OF MAN WITH FOREST RESOURCES

Man's food is drawn, directly or indirectly from the vegetable kingdom. The meat-eating people get their food from cattle or sheep which thrive on vegetation. The vegetarians get their food directly from plants. Even the fish which provide so much food to man depends ultimately on a form of vegetable growth, known as plankton. No matter what one of the basic human needs we consider—food, clothing, or shelter—we must depends on plants. Fig. 15·4 shows the ecological cycle of forest resources. The ecological adjustment of men with vegetation is divided into following groups :

A. Man's direct adjustment with vegetation—
   1. Lumbering
   2. Pasturing
   3. Hunting and Gathering
B. Man's indirect adjustment with vegetation—
   4. Agricultural adjustment
   5. Commercial adjustment
   6. Industrial adjustment.

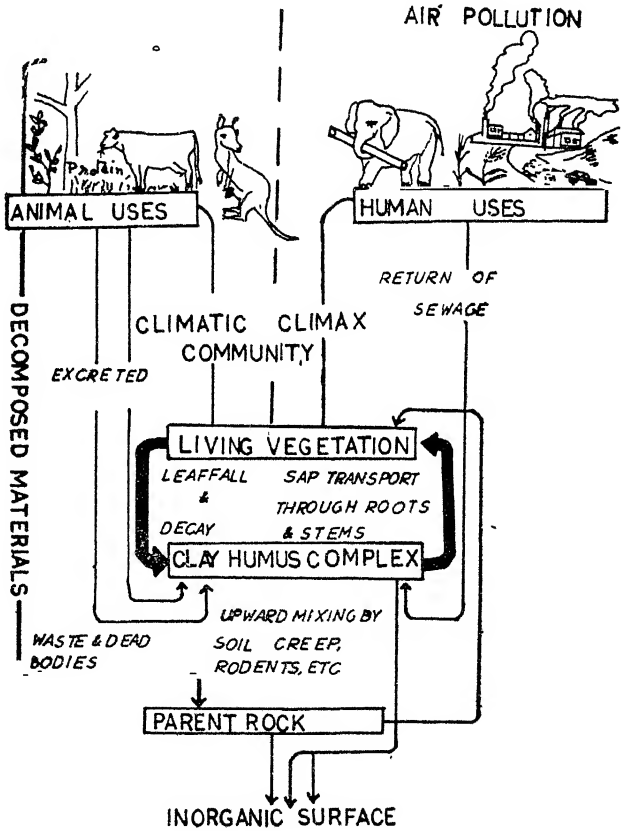

Fig. 15 4. Ecological of Cycles of forest resources.

Lumbering—As the nation's population continued to grow, as the demand for lumber increased, and as transportation facilities improved, one tract of virgin forest after another yielded to the ax and the saw. Lumbering is important and primary occupation all over the world. Large tracts of tropical and temperate forests have also been cleared for agricultural purposes and the forest in the

neighbourhood of dense population have suffered from severe biotic factors such as overcutting, over grazing and fire.

Logging is a exploitive adjustment to flora. It will be realized that with the density of population that obtains in the habitabal parts of the globe, the effect of man must be very great. Except in areas difficult of access almost none of the vegetation is undisturbed. Man affects the natural vegetation, always adversely, by cutting and pollarding the forests for fuel and fodder, by grazing his domesticated animals, by clearing for cultivation, and by setting fires to destroy dry grass.

FAO estimates placed the annual removal of wood from the forests of the world in use at about 1,400,000,000 cu. m. Industrial wood comprised 54% of all removals and fuelwood 46%. Conifers contributed 78% of the industrial wood but only 27% of the fuelwood. Table 15·4 shows the production of round wood of selected countries.

Table 15·4
Production of round wood, 1971
(Figures in ten million cu. metres)

Country	Conifers	Broadleaf	Total
World	**109**	**130**	**239**
U.S.S.R.	32	7	39
U.S A.	26	8	34
China	8	9	17
Brazil	2	15	17
India	0·5	11	11·5
Canada	11	1	12
Indonesia	N.A.	11	11
Sweden	6	0·7	6·7
Nigeria	N.A.	6	6
Japan	3	2	5
Finland	3	1	4
France	1·5	2	3·5
Tanganyika	N.A.	3	3
W. Germany	2	1	3
Colombia	N.A.	2·7	2·7
Sudan	N.A.	2	2
Turkey	1	0·8	1·8
Pakistan	N A.	1·7	1·7

Table 15·4 clearly shows that conferous forests represent a very substantial item of the countrys national wealth particularly in U.S S.R. and U.S.A. Canada ranks third in round wood production, while Brazil ranks first and India ranks second in round wood production from Broadleaf forests.

Pastural Adjustments to Forest Resources—In the economic history of most regions, pastural adjustments to forest resources has occurred in the early stages of development. This is true even of many forest regions. It is true that ecology determines the nomadic habits of the dweller of prairie and steppe. The distribution of pasture and water fixes the scope and the rate of his wandering ; these in turn depend upon ecological conditions and vary with geographical locations and the season. According to White and Renner the pastoral industries represent direct adjustment to grassland habitats or partial adjustment to a habitat wherein grass is present.

Owing to the wide differences in climates of various parts of the world and to the influences, of edaphic, biotic and physiographic factors, the vegetation also differs widely from semidesert Savanna (grass and shurb vegetation) of the lowest plains, to the fir and spruce-fir forests of the High mountains.

On the hill sides where there is only a very small depth of soil above the parent rock, either because of erosion or because the slope is too steep to permit a deep soil to form, tree growth is unable to establish or maintain itself. In these places there is a growth of fine grasses such as *themeda arundinacea*, *Neyrondia Arundinacea*, etc.

On the western side of Asia between the central plateau and the Urals there is too little rain for broad-leaved forests to grow in quantities. There south of the 'Taiga' is a belt of park-like grassland nearly 480 kilometres wide from north to south, where good grasslands are sprinkled with occasional forest trees.

Much of the soil is black earth and is very suitable for wheat growing. Now, that new kinds of wheat have been produced which will grow quickly following the melting of the snows in spring, and ripen quickly after the gentle summer rains, before the frosts of autumn begin, this part of Siberia may become one of the granaries of the world and storehouse of the world. Twice as much wheat is grown as is needed, the rest is exported. The cultivated lands are generally beginning to encroach southward from Omsk upon the grass steppe of the Khirghiz nomads of Turkestan, who do not take kindly to ploughing and corn-farming.

The winter snows provide the moisture for the plant growth in early spring, the summer rains are sufficient to feed the swelling kernels just before harvest, but late frosts and summer droughts at times make wheat-growing risky.

The prairies form the North American counter-part of the *Pampas* of South America, the *steppes* of Eurassia, and the *Veld* of South Africa. Prairies are gently undulating, almost flat, generally treeless grassy plains—the intermediate Grasslands—of North America, covering the southern regions of Alberta, Saskatchewans, and Manitoba in Canada and the central United States from the foothills of the Rocky mountains about as far east as the longitude

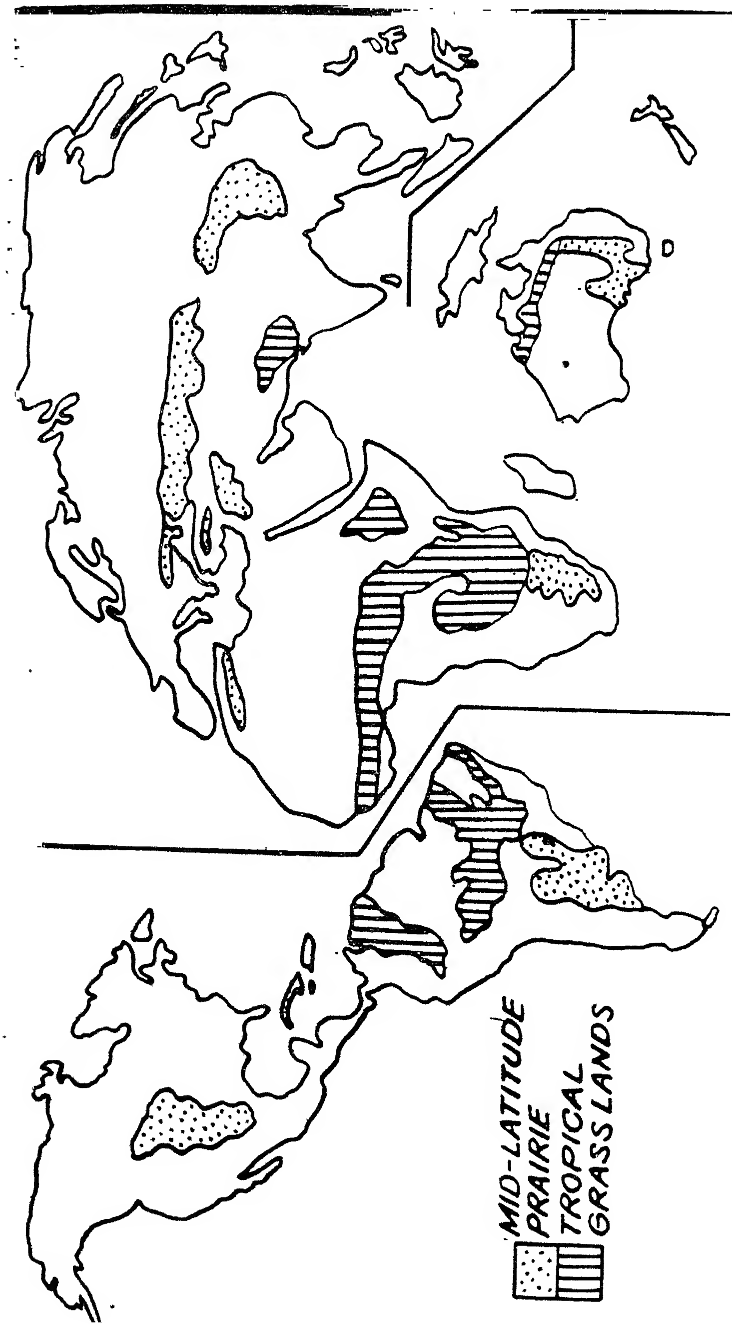

Fig. 15.5. Distribution of Grasslands

of Lake Michigan. The light summer rains, with local droughts and high summer temperatures, permit a rich growth of natural grasses, but not, in general, trees ; these conditions are also suited to the growth of cereals, and the prairies have become one of the most important areas of wheat production in the world. Fig 15·5 shows the distribution of grasslands of the world.

Exploitive Adjustments to Vegetation

The exploitive adjustment to vegetation commonly appear in three forms : tapping, forest hunting and gathering and Silviculture.

Tapping—Under suitable conditions the tapping of resin in *chir pine* forests, for the manufacture of turpine and rosin, has shown itself to be a highly profitable industry ; recent years have seen a great development in resin—tapping operations, both in the old and new world, and under favourable conditions the revenue derived from resin is larger than that derived from timber and fuel. There is still room for very considerable expansion in the resin industry, and hence in many localities schemes of resin-tapping must influence the management of chir pine forests in no small degree.

There are two classes of tapping—(1) light tapping and (2) heavy tapping, sometimes termed as tapping to death. The former consists in making a moderate number of blazes, and is carried out in the case of trees not due to be felled within the next few years.

The latter consists in making as many blazes as the tree will hold, and is carried out in the case of trees due to be felled within five years, the object being to obtain as much resin as possible before the trees are felled.

Rosin and turpentine industry figures prominently in the *chir-pine* forests of the temperate region. Rosin is an important industrial raw material as it is used in the paper, soap, surface-coating, frames and disinfectant industries. Production is insufficient to meet the growing demand at present.

The importance of forest produce is not so much in the present stage of development as in its future possibilities. Bamboo, some of the grasses, oils and tanning materials produced in these forests are capable of providing inexhaustible supplies of industrial raw material.

Katha and cutch are extracted from the hard-wood of *Acacia catechu* or Khair. Lac is of economic importance to India and Thailand. It is also the main cash crop of tribal population of India. Lac is especially used in wood working, insulation moulded components, grinding wheels, paper laminates etc. In recent years it is facing keen competition from synthetics.

The minor forest products of the world which are commercially important are bamboos and canes, fodder and grazing, gums, resins, lac, grasses other than fodder grasses and products, which are of use in perfumery or medicine. Four of the above products,

namely lac, myrabolans, gum and *beedi* leaves, occupy positions of considerable importance in world's international trade. Reliable data about internal consumption, trade and carry over of stocks from year to year are not available.

Besides the above exploitive adjustments to flora, large quantities of *attar* of roses, *jasmines* and *pandanus* etc. are distilled and absorbed on *Sandal*-wood oil; also floral waters of rose, pandanus, aniseed, spear mit, etc. The scope of essential oils is so extensive that it practically embraces many spheres of human interest; they are used in the manufacture of products like soaps, cosmetics and toilet preparations, perfumes, disinfectants and antiseptics.

It has already been pointed out how the forests of the world were originally the haunts of hunting communities, and the steppe lands the home of shepherds. In the remote past, many peoples lived entirely by hunting the wild fruits, nuts, roots and berries of the forest. Even at the present time, there are fragments of primitive forest peoples who live almost entirely by this means. Hunting and fishing, besides nomadism, are the most important occupations of the Paliyans, Kadars, Urali etc.

The gathering of nuts is yet another form of forest hunting. The gathering of forest products on a commercial scale constitutes an outstanding phase of the economy of many regions today. Particularly is this true of the Tropical forest lands. Many of the trees of the selva yield a juice or latex which may be made into valuable products. For example, a milky liquid known as latex which is tapped from the bark of a wide variety of Tropical trees. The latex exudes from an incision in the bark and flows into an attached receptacle. Daily collections are made and the latex is brought to the factory where crude rubber is extracted. This consists of coagulating the latex, mechanically milling the doughy coagulum to remove most of the moisture, curing the sheets by smoking and drying.

Commercial adjustments—The forests of the world are now of importance mainly for their yield of timber. It is the growing demand for timber that is year by year reducing the forest areas of the cool temperate regions and compelling serious consideration of their wasteful exploitation.

Large but unknown volumes, chiefly of hardwoods, occur in regions where the percentage of forest in use is low. Latin American countries, for example, has 23% of the total forest area of the world but only 8% of the growing stock in forests in actual use, with large reserves in unexploited forest resources. Conifers comprises 55% or the total growing stock in forests in use and non-conifers 45%.

The steadily increasing use of wood resulting from an expanding population and a rising standard of living tends to put a severe strain on the forest resources of the world. Two-thirds of the total industrial and fuel-wood came from North America, the

U.S.S.R. and Europe. Industrial wood comprised 84% of the total, with the same three regions leading in the same order of importance. Fuel wood comprised 90% of total removals in Africa, 84% in Latin America and 62% in Asia. Table 5·5 shows the removal of wood from various regions.

Table 15 5
Removal of wood from Forests of the world[1]

Region	Total (000,000 Cu. m.)	%	Industrial wood % of world	Industrial wood % of region	Fuel wood % of world	Fuel wood % of region
Europe	303	19	21	64	16	36
U.S.S.R.	328	21	24	67	16	33
North America	416	26	39	86	9	14
Latin America	179	11	3	16	23	84
Africa	102	7	1	10	14	0
Asia	227	14	10	38	21	62
Pacific Area	28	2	2	75	1	25
World	**1,583**	**100**	**100**	**58**	**100**	**42**

The coniferous trees of the colder forests yield by far the larger part of the world's supply of useful timber. Many of the woods of the deciduous trees are of great economic value, but coal and iron are now used for many of the purposes for which these woods were once required in quantity. The pine woods are soften and more easily worked, and not only is the demand for the old purposes, such as house-buliding, increasing, but newer uses, as the making of wood pulp for paper manufacture, are constantly being devised. "Here they could obtain ample supplies of materials like turpentine, pitch and resinous timber It is only very recently, however, that these pine forests have suffered large scale exploitation. The wood of these southern species of pine" according to Eyre, "is so resinous that it was unsuitable for wood-pulp manufacture when this industry became important in the early twentieth century. It is only during the last two or three decades that techniques have been devised for using this wood for paper manufacture."[2] Now so great is the demand that many parts of this region are now under careful regulation, fresh trees being planted to replace those taken out, but it is doubtful if the supply from at last the more accessible areas would meet the present demand if the rate of abstraction were nowhere greater than that of replacement by fresh growth. The question is one which, if not yet acute, has already appeared above the economic horizon, and it makes it all the more unfortunate that so few trees in the tropical forests, which cover such vast areas that are apparently of little possible use for anything else, furnish useful timber.

1. FAO and United Nations year book of various years.
2. Eyre, S. R.—op. cit. pp. 63-64.

These forests are composed of very large number of species, only some of which are, at present, of value, The most important varieties of trees that are at present exploited are the following—

Conifers evergreen species–Species of pine, spruce, firs larches, birches, aspens are particularly common and widespread. Except larch, the vast majority of conifers are evergreen and account for their widespread dominance. These trees are tall evergeen coniferous, with soft white, not very durable, wood suitable for planking, packing cases, wood pulp and matches.

The *chir* is another large size conifer growing to a height of 18 to 30 metres. The *chir* forest overlaps the tropical deciduous forest at the lower elevations; while it gives way to the temperate forest above. It is extensively developed in Kashmir, Panjab, Himachal Pradesh, U.P., Nepal and Bhutan. The absence of the *chir* forest on the southern face of the outer range of the Himalayas is noteworthy, and is due to the combination of excessive heat with heavy monsoon rainfall. The *cnir* wood is light reddish brown and moderately hard. It is used largely for making tea boxes. The chir is now extensively tapped in U.P., H.P., and the Panjab for the manufacture of resin and Turpentine.

The broad-leaved species—The important species are *sal, teak, babul, shisham, kikar, khair kanju* etc. The *sal* tree is most important timber which has come into prominence, due to its large use for railway sleepers. It is, therefore, an added advantage for the exploitation of the *sal* forests, as the railways can pay higher prices than building and other trades for the sal sleepers. *Babul* and *shisham* which occur scattered over large areas in the drier parts of the monsoon region provide good timber for local use. Teak is also important commercial timber in monsoon Asia as shown in Fig 15·6.

Industrial Adjustments—Forests play a vital role in national economy. They are an important source of fuel and also of raw materials, such as timber, bamboos, lac, gum, *katha*, useful for domestic, industrial and agricultural purposes. During the past decades, many industries based on forests products have been established. Among the industries establishment may be mentioned saw-milling, packing cases, cabinet-ware boat, building, aircraft industry, textile auxiliaries, sports goods, battery separators, pencils, matches, plywood, building boards, paper and pulp, bamboo and cane articles, essential oils, drug, tannin etc.

From very early times, forests and forest products have been so intimately associated with man and his activities that it is difficult to isolate them for an objective ecological study. During past decades, many industries based on forests or forest products have been established. Among the important industries established may be mentioned paper and pulp, matches, plywood, saw-milling sports goods, etc.

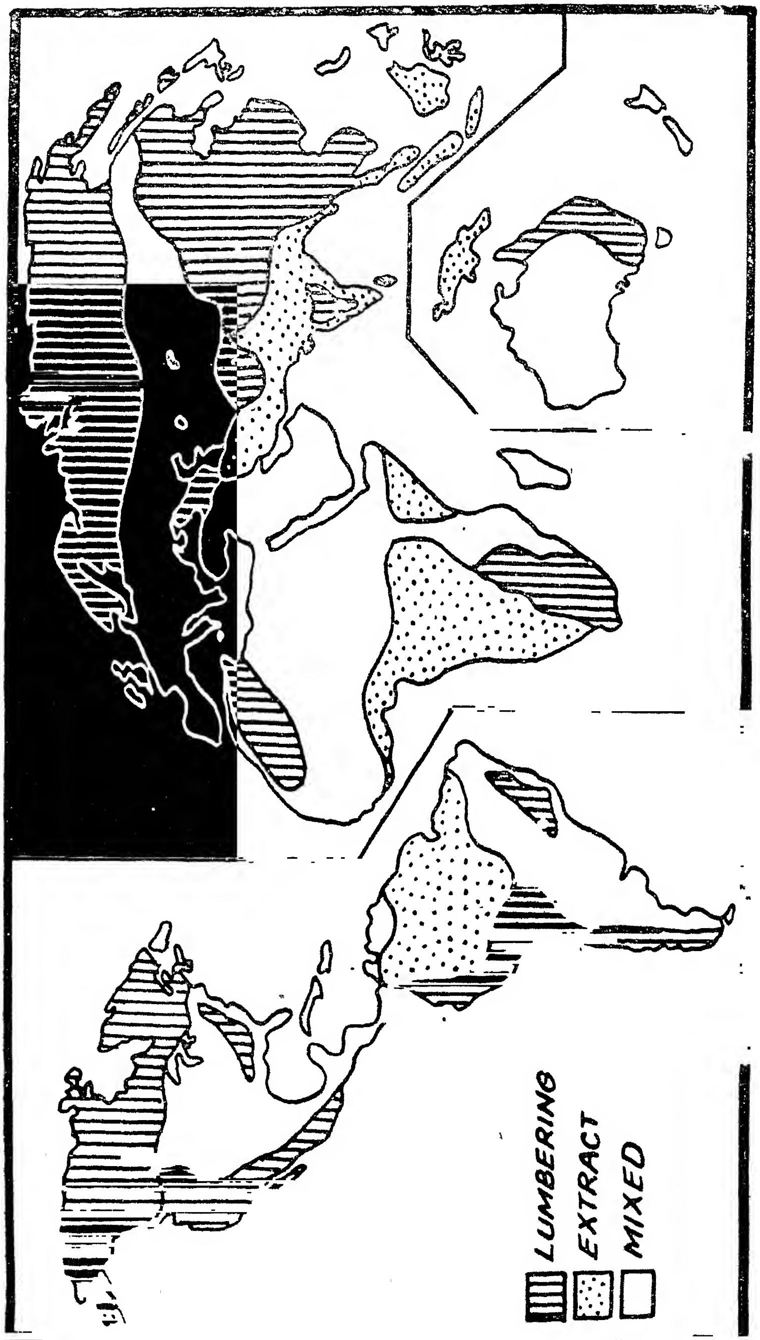

Fig. 15·6. Forest based Industries.

The *Sabai* or the *Bhabar*, Esparto grass of Africa, coniferous trees, fir, spruce and pine are used for pulping. The major pulp producing countries of the world are Canada, Norway, Sweden, and U.S.A. In Norway and Sweden the major commercial tree species and the Scots Pine, Norway Spruce, fir and larch and these are exploited for both sawnwood and pulp and paper, though the pulp industry is much the most important, especially in Sweden. Table 15·6 shows the production of pulp of the world.

Table 15·6
Pulp Production of the world*
(Figures in lakk metre tons)

	Mechanical Pulp	Chemical Pulp	Total
U.S.A.	68	330	393
Canada	69	94	163
Japan	13	78	91
Sweden	14	64	78
U.S.S.R.	16	48	64
Finland	20	43	63
Norway	13	9	22
France	5	13	18
W. Germany	9	8	17
China	5	8	13
Austria	2	7	12
Brazil	3	5	8
Italy	5	3	8
Spain	2	5	7
Poland	2	5	7
Australia	3	4	7
S. Africa	1	5	6
NewZealand	3	3	6
Chile	1	3	4
World	**265**	**778**	**1035**

The match industry is a very important one as it not only deals with an every day commodity, but is also a good collector of revenue to various governments at little cost. The largest production of matches is in the neighbourhood of Calcutta where Indian wood is mostly used. The Indian wood is used in Calcutta, *Genwa*, though, *pipita* and *dhup* from the Andamans are also used ; *didu* and *Bakota* also come from the Andamans. *Genwa* is available in large quantities in the Sundarbans.

*U. N Stat. Year Book, & Monthly Bull. Stat. 1972, 1973.

The next important centre for the industry is Bombay where the wood is imported. But there are some factories in Gujarat Kerala and other parts of Maharashtra where Indian woods are used. These woods are *simal*, mango and *Salia*. These woods do not grow in large quantities at one place. Plantations of *simal* have now been undertaken by some factories. *Simal* is very good for box-wood, but is inferior for sticks. In fact, there is no Indian wood, except perhaps the mango, which is as good for splints as the imported aspen. About 25 species has been considered suitable by the Indian Standard Institution and the Institution has investigated the suitability of 93 other species.

The saw-mill industry is distributed throughout the world. The saw dust is at present mainly sold as fuel.

Agricultural Adjustment—Man once a carnivorous hunting animal along with other carinvora in the jungle. Micro-organisms lived on animal and plant refuse and rendered nutrition in the soil available for plant life. Plant life provided the food for the herbivora and these in turn were preyed upon by carnivora including primitive man. The influence of man in the destruction of plants is most serious. Apart from the reckless cutting that is common to all parts of the world. Many parts of the world forest in tropical and temperate region suffer from the practice "Jhuming" or Shifting cultivation, which the backward tribes follow to clear the ground for cultivation. All the vegetation, even the largest are cut down in the cold weather. During the hot weather, the debris is set fire to at the lowest part of the "Jhuming," the rising flams cause an upward draught and the charred and blackened trunks of the largest trees. As soon as the embers have cooled down, various seeds, such as rice, millet pumpkins etc, are dribbed into the earth with the ashes. The field is weeded once or twice during the rains before the crop is harvested. Next year and the following year the field is cultivated and then when the accumulated fertility of the soil has become exhausted. Mainly through exposure and erosion, the area is abandoned. In areas where there is a real land hunger, the 'Jhumias' return at shorter intervals to the some field and the inevitable result is that the area does not get a chance covered with tree at all.

The erosional effects of forest clearance—The denudation and degeneration of the forest cover of the mountain ranges has already led to serious problems of erosion all over the world. How this man-made factor operates is shown by an example from Himalaya. Until independence, human settlement in the Himalayas concentrated around the rice lands of the hot humid valleys. But recently the oak and pine forest have been removed to make way for potato and maize cultivation in the name of horticultural belts, with the result that the ridges have been denuded and erosion intensified.

Those who have been visiting Kulu-Manali in the last few decades will have noticed the rising tide of barrenness as the beauti-

ful conifer forests are felled to expand the area of cultivation above the valleys.

The destruction of the rhododendron belt along the new motorable road to Nathula has cost our Government much more than the capital cost of road-construction, because of recurring maintenance costs through land slides. Not only has this erosion led to a decline in soil fertility in the mountains but also to an increase in the frequency and magnitude of the floods of the Ganga and Indus plains, even as our dams and canals, barrages and projects, render river valleys in the plan incapable of canalising the flooded streams. Floods are filling up our dams and silting faster than we can build them or deepen them. The vast expansion of roads which cut across the natural drainage of the mountains and the plains are an additional disturbance to the natural forest ecology of the country.

Vegetation helps to check drought damage in dry seasons and reduce flood crests in small and large streams in wet times. It reduces siltation of streams, reservoirs and harbours, thus helping to insure a cleaner water supply for cities and towns, improve navigation and provide a better habitat for fish and other forms of wild life.

The climate, population distribution and density and the agricultural possibilities have been moderated by the plant ecology. This is why the northern aspects of the Himalayas and associated mountain ranges, have always been much drier, with few glaciers, except where the westerly winds have brought winter snowfall in the northwards slopes. The southern aspects of the Himalayas have been lush regions of forested hills rising from the humid *Terai* through mixed forest to pine and conifers, and the temperate forests higher up near the snowline.

We are fully aware that the glacier cover of the earth which keeps 1/6th of the earth's water supply locked up in the form of glaciers and ice-sheets has always fluctuated. There have been a series of glacier cycles when glaciers advanced and retreated thousands of kilometres from the North Pole outwards. One such advance of the glaciers from Himalayan ranges to Northern Plain of India from time to time and we are now living through the fourth cycle of glaciation in recession. All over the planet, glaciers are receding and sea-levels are rising due to ecological imbalance. Forest ecology also provides a cleaner and more beautiful country side or landscape.

The use of vegetable drugs would probably be the first to recommend itself to those seeking relief from pain and disease, because plants are everywhere at hand, their number is very great, and their forms are distinctive and often peculiar, and in some cases they have been supposed to bear a more or less obscure resemblance to certain parts of the body either in health or when diseased. The medicinal use of preparations of vegetable drugs has

been for a long time of the greatest importance, and until a comperatively recent period the number of drugs obtained from plants and animals greatly exceeded that the preparations from the mineral kingdom. This depended on the fact that until chemical knowledge was fixed on a firm basis, it was only with great difficulty and after many failures that chemical products could possibly be obtained; while on the other hand, the different parts of plants to which a medicinal use was assigned were easily distinguished and procured without much trouble.

The present medical practice in our villages is mainly done through the add of these forests providing in numerable medicinal herbs. Many plants having medicinal healing properties are used in the world of medicine today. One such plant is cinchona which is used to combat malaria, the dreaded scourge of man.

Quinine was prepared from Cinchona in a rough state in 1972 by Foureoy. But it was only 28 years later that two other French Scientists, Pelletier and Caventou, succeeded in isolating pure quinine. Even now it is the only good medicine for malaria because the other two Synthetic drugs prepared during 1924 and 1935, Plasmodin and Atabrine, are not able to kill the sporzoa as completely as quinine does.

By 1860, cinchona plantations were started in India, Ceylon, and Java. Attempts were made to grow the plant in Europe but the climatic conditions there were not suitable for it. Today, there are plantations in Australia and Jamaica also. In India, cinchona plantations are in the Nilgiris, the Annamalai hills, wynad in Malabar and in Assam. Next to Java, India is the biggest producer of this wonderful plant.

PART VI

HUMAN RESOURCES

CHAPTER 16

GROWTH OF HUMAN RESOURCE

Human and Physical Resources

Prior to the industrial Revolution, when agriculture was man's main activity in nearly all countries, the population distribution in each country tended in the course of time to become more or less adjusted to variations in the quality of the land. According to George, the typical result was an uneven distribution ; population was heavily concentrated on lands which could produce large returns with minimum equipment, while other lands which were inferior in quality or which could yield large crops only with substantial capital equipment, were less densely settled. However, in comparison with the distribution which subsequently evolved in the countries that become highly industrialized, this pre-industrial distribution of population was one of relatively uniform density over wide areas.[1] The danger of world population reaching the maximum that could be supported by the earth's resources seems remote in the light of the findings reviewed in Chapter 20 of this book.

The industrialization and mechanization of the world economy have increased the importance of natural resources as a factor influencing the distribution of population. The present distribution of industry and trade in such countries as the United States; U.S.S R; U.K; France, Germany,. Australia and Poland reveals the prime importance, at present, of the availability of resources and technological development as a base for industrialization.

Historical Growth of Population

Our knowledge of population trends comes mainly from the census and these cover only the earlier part of the seventeenth century. Prior to 17th century we have guess estimates and while these figure can not be taken to seriously they represent certain approximations. At the beginning of civilization about 5000 B.C. the world population was probably not much more than 20 million. It is thought that the total population at the time of Christ was around 200 to 300 million people, and that it had increased to about 500 million by 1650. It grew quite slowly until about 200 years ago, by which time it had reached 700 million. In the last 200 years the number of people in the world shot up very quickly. By 1850 it had doubled and by 1960, it had doubled again, making a total 2800 million. The way things are going it looks as though the number will double again by the year 2000,

1 George, Geographical Distribution of Population, pp. 21–31 ; 1951.

making a total population of 5000 million. The course of human population growth can be seen in Table 16·1.

Table 16 1

Growth of Population[1]

Date	Estimated world Population	Time for Population to double
8000 B.C.	5 million	
1650 A.D.	500 "	1500 years
1850 A.D.	1000 "	200 "
1930 A.D.	2000 "	80 "
1973 A.D.	4000 "	47 "
2000	5000 "	27 "

Biggest Increases

The population of some countries is growing more rapidly than others. In Asia, Africa and Latin America the biggest increases are taking place. At the beginning of this century there were twice as many Asians as Europeans; by the end of it, it looks as though these will be four times as many.

According to the American Bureau of Population studies of the world, which at present has a population of 3,300 million, will have 1000 million more by 1980. The World population is growing at the rate of 65 million a year, that is, more than the population of Great Britain According to the calculations of American experts the world population in 1980 will be 4300 million and the largest proportional increase will be in Latin America. The present Latin American population of 291 million will be 374 million in 1980.

China, whose population is at present estimated at 773 million will have another 150 million by 1980. After People's Republic of China, the most populous countries of the world at present are : India 547 million (increasing at the rate of 10 million a year). The Soviet Union 245 million, the United States 207 million, Indonesia 124 million, Pakistan 141 million, Japan 104 million and Brazil 95 million.

At the other end of the scale, Malta, Kuwait, Luxemburg and Iceland have less than 500,000 inhabitants.

More than half of the world's inhabitants (over 56 percent) live in Asia. But it is neither China nor India which is the most fecund country. Increases in the birth rate are most marked in Latin American countries. Brazil, for example, doubles its population every 23 years and all the central American Republics have an annual growth rate of more than 3%. Latin America is both the fastest growing world region in population and also the most advanced (in terms of the death rate, literacy, and per capita income) of under developed regions of the world.

1. Population Bulletin, Vol. 18, no. 1.

Growth of Population

Change in the size of a population whether increase or decrease, is called growth. Fig 16·1 shows the growth of population in various stages of populalion cycle. As regards the growth of population one thing is obvious; the growth has been due to a surplus of births over deaths. If we knew accurately the population of the world in 1650 and also today, the amount by which the second figure exceeds the first would give us the excess of births over deaths during the period. In order to deal with this problem we may employ crude-birth and death rates. These rates are

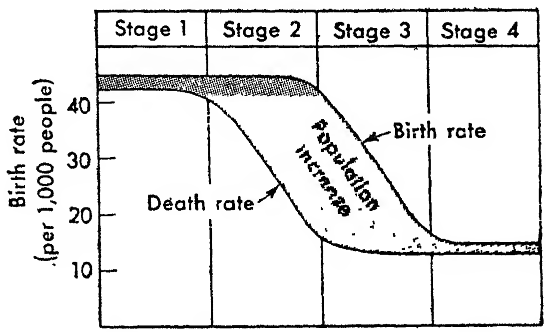

Fig 16 1. Growth of Population (from Karl Sax, Population Explosion No. 120–1956)

obtained by refering the total births and deaths which occur in any country during a year to the population for that year and expressing the result per 1000 of the population. Thus the estimated population of X country was 40,467,000 in the middle of the year 1970, the number of live births which took place during the year was 598,084 and the number of deaths 476,853. It follows that the birth rate was 14·8 and the death rate 11·8 per 1000 The difference between them was 3·0 per 1000. Since births exceeded deaths the difference is called natural increase; if deaths had exceeded births it would have been called natural decrease. It is clear that in most parts of the world, since in most places population was increasing, that is only another way of saying that births were exceeding deaths. But before this period, since population was either stationary or increasing slowly, there was either no natural increase or only a small natural increase. Thus we may say that before this period birth and death rates were running at about the same level, and that during this period birth was running well above the latter. Clearly this divergence can only have occurred either because the birth rate rose, or because the death rate sank, or because both took place together.

FACTORS OF GROWTH OF POPULATION

Growth of population is affected by four factors—births,

deaths, immigration and emigration which are taking place in every corner of the globe in some extent.

Birth and Death Rates

In order to calculate birth and death rates for any region we must know, not only the number of births and deaths but also the total population of the area in question. The birth rate is usually expressed as the number of babies born per thousand married people per year. The total number of births during the year is divided by the estimated population. Suppose that in X country there were 3,729,000 live births during the year 1971. The population was estimated to be 205,200,000. The birth rate for that period was therefore 3,729,000/205,200,000 = 0·0182. There were 0·0182 births per person that is 0·0182 × 1000 = 18·2 births per thousand people. Similarly, there were 1,919,000 deaths during that periods, giving a death rate of 1,919,000/205,200,000 = 0·0094 × 1000 = 9·4 deaths per thousand people in the same year.

Growth Rate and Size of Population

There has been no accurate record of human population sizes until quite recently, and even to day demographic statistics for many areas are unreliable. World population seems to have grown at a rate of about 0·3 percent per year between 1650 to 1750. The growth rate increased to approximately 0·5 percent between 1750 to 1850. The average growth rate of the world population between 1850 to 1950 was about 0·3 percent per year. Population increased in that time from slightly more than 1098 million to almost 2370 million Between 1850 to 1950 the population of Asia did not quite double, but population more than doubled in Europe and Africa, multiplied about fivefold in Latin America and increased more than sixfold in North America.

The global growth rate was 1·9 percent between 1950 to 1960. The most populated country was China with 773 million, followed by India with 547 million and the U.S.S.R. with 245 million. The current world live birth rate is 33 per 1000 population, against 34 to 35 in 1965 and 35 to 36 per 1000 in 1960. The highest birth rates were recorded by Pakistan, Jordan, Laos and Tanzania. Pakistan had a rate of 49 per 000 or more than three times that of most west European countries, and nearly three times that of the U.S.A. and Canada.

In 1962 the world's population numbered something like 3150 million. If estimates of the past are to be regarded as having any value, population seems to have been increasing steadily for many hundreds of years, as the following table 16·2 shows :

Table 16·2
Growth of Population since 1850.

Year	Population in Million	% Increased
1650	465	+·29
1750	660	+·20
1800	830	+·24
1850	1098	+·30
1900	1550	+·15
1930	1833	+·19
1950	2370	−·09
1962	3150	+·15
1972	3706	

The regional growth rate was : Asia 56 percent, Europe 13%, Africa 9·7 percent, Latin America 7·8 percent, the USSR 6·7%, North America 6·3 percent and Oceania 0·5 percent.

Although population distribution in the Oceania and Asia is extremely uneven, the present trend is toward increasing unevenness ; in other words the nodes of denser population—cities or regions—are experiencing more rapid population growth than the areas of sparse population.

China's first official Census was held almost exactly 23 years ago in June 1953. Its results published in November 1954 gave a total of about 582 million for the Chinese mainland (excluding Taiwan and overseas Chinese). But in view of the low quality of China's statistical services in those days, it is doubtful if the figure reflected the actual population with any accuracy. Even so, the Chinese continued to operate with this figure as the base for further projections. The total of 646 million for 1957 recorded in their statistical handbook "Ten Great Years" seems to have been extrapolated from the 1953 census figure.

During the early 1960s, the Chinese Press used to round figure of 650 million without adjusting it for yearly increases. Then, suddenly, around 1965, the upgraded round figure of 700 million began to be mentioned. It appears that in May 1964 the Chinese carried out a second population census in great secrecy and this yielded a total of some 680—690 million. The variations in the totals released by different departments and individuals—all presumably official figures—are so wide that accurate statistical analysis is impossible. For example, a Chinese School Atlas published in 197ı records that the population of China in 1970 stood at 697 million. The food Agencies thought that it was more than 800 million whereas the Ministries of Industry took it to be less than 800 million.

The confusion about the exact size of the Chinese population has been confounded even further because official Chinese sources have, at different times, released population figures which do not tally with each other. Chinese watching demographers thus have had a field day guess-estimating China's population. Depending on their political biases and methods of analysis (based on estimates of birth and death-rates, food production consumption levels etc.) they have arrived at totals ranging from 700 million to 900 million. Guessing the size of China's population has become an exciting numbers game. China's population may increase at the most conservative estimate somewhat as follows :

1957	646 millions
1960	650 ,,
1965	700 ,,
1971	850 ,,
1976 (estimated)	930 ,,

The population of Russia has always grown rapidly. Prior to the First General Census, the population of Russia doubled, roughly speaking, every sixty years, and increased yearly from the census of 1897 upto the outbreak of the First World War by more than 3 millions. The yearly increase of population in the U.S.S.R., according to the census of 1926. was also over 3 millions.. But since 1926, according to the Census of 1939, the population increased by only 23,439,271 or less than 2 millions a year.

The rate of population growth in Java, which appears to have risen from the mid-nineteenth century to 1930, fell slightly until 1939 but since that time has increased substantially. Between 1920 and 1930 the population grew at an average rate of 1·8 per cent per annum, rising to 2·0 per cent between 1930 to 1960. Population growth in Java will probably remain high for some years to come, and may even increase, for the decline in mortality, especially infant mortality, is likely to continue, while birth rates may well be increasing with rising standards of living.

The population of Japan according to F.A.O. in 1934–38 was 69·2 millions and in 19 0 was 83·2 millions, a rise of about one percent per annum ; the area of cultivated land is thus only about ·06 hectare per head, the lowest in the whole world. With the possible exception of China and India, Japan is the third largest populated country in Asia. The population of Japan numbered 44,285,000 in 1900 and at the end of 1971 it was 104,700,000, more than three fold total increase since 1900. The Japanese population has increased at an average annual rate of about 5·7 percent between 1900 to 1971. While natural increase accounted for 57·5 percent of increase in the population as a whole. The rate of population growth, which appears to have risen from the beginning of the twentieth century upto 1940, fell slightly after 1941. This acceleration in the annual rate of population growth was checked

between 1940 to 1945, when the growth rate fell first to ·02 percent. The growth rate was constant during 1945 to 1949. But since that time has increased slightly upto .961 and again felt second time since 1961 to ·01 percent.

The growth of population is determined by the relation which exists between the brith and death rates; and this again depends partly on the racial characteristics and social practices of the people and partly on external conditions such as their material well-being and the state of public health. In the Middle East the birth rate is everywhere much higher than in Europe, but this is due largely to the Universality of marriage—Polygamy and remarriages of widows.

Britain is the most important country of Europe, whose population increased from 7 millions in 1700 to 40·0 millions in 1931 and 56·3 m. in 1971. In 1801 the population of England and Wales was 8 millions. One hundred and seventy years later, at the census of 1971, it was 56·3 m. and increasing at the rate of about 200,000 a year.

It would not be in appropriate to examine the growth of population in some important countries of North America. In 1851 the population of Canada was 2,436,297. - One hundred and twenty years later, at the census of 1971, it was 21,000,000. Between 1931 and 1941 the average annual rate of population growth was 1·3 percent, rising to 1·8 percent between 1941 and 1951 and to 2·3 percent during the last intercensal period. The latest estimates suggest that the population reached a total of almost 21 million in 1971.

Population of U. S. A. has doubled in the past thirty five years. The growth rate of population in U. S. A. was 30·1 percent during the decade 1870—1880, 25 5 percent during 1880—1890, 20·7 percent during 1890—1990. The population of the U. S. A. numbered 179,323,175 in 1960 of whom 18,871,831 were Negroes. The Negroes population has increased at an average annual rate of about 2·3 percent and the white population at about 1·5 percent, while natural increase accounted for 18·5 percent of the increase in the population as a whole, it contributed 23 percent of the increase in the Negroes population. The estimated population of the United States at the end of 1971 was 20 ,000,000 including Negroes, more than a threefold total increase since 1900.

The growth of population varies considerably in the different geographical divisions of the United States. In the west South and East-North central, which contains the bulk of the white, cotton and corn belts and has large stretches of land waiting for cvltivation, immigration of cultivators from western Europe and colonization by Britishers and Negro labourers has substantially increased. It is this part of the State which is best able to absorb the new population, and it is here that expansion has mostly taken place, rather

less than half the increase of the decade being due to in this tract to the effects of immigration. Perhaps the most significant aspect of this growth is the broad belt of rural increase reaching eastward from South eastern wisconsin to Southern New England and taking in much of American north eastern Megalopolis ; these are countries which, though they had for the most part dropped well below their initial nineteenth-century maxima, have recovered vigorously in recent years.

Migration. Two great demographic processes have long been going on in the world. One is the natural increase of total population, the excess of births over deaths, now commonly referred to as the population explosion. The other is the movement of people from place to place—that is, migration. These two processes are intimately connected with the growth of population. The same technological advances that make possible the growth of population also promote its concentration in particular places. One reason is that economic development occurs earlier, or more rapidly, in some parts of the world than in others ; in such areas, numbers also increase more rapidly. A more fundamental reason is that industrialization promotes the growth of cities. People no longer needed to till the soil tend everywhere to congregate in urban centres.

The rapid growth of population has caused massive migration from the rural areas to the cities for jobs and amenities and other opportunities and attractions that city life offers. This has resulted in overcrowding of the urban areas, intensifying the housing problem which is already acute in almost in all urban centres.

In their geographical and cultural scope the most spectacular migrations in history have been the great overseas movements of peoples from the old world to the New. Indeed, hardly a country in Europe has not been vitally affected by Trans—Atlantic emigration during the past four centuries. One of its major components is forced mass transfers of population, such as those between Germany and Poland after world war II and between Pakistan and Bangla Desh after the formation of Bangladesh. Emigration is often closely linked with internal migration, but such migration is also important in its own right Most important, however, is movement from rural to urban and suburban centres.

Growth is worse than Bombs

Nobody douts that it is technically possible to freeze the world population at its present level of 3·7 billion, but few think it is necessary or desirable. The fact is that if the growth rate persists the figure will double in 30 years. This is a subject often discussed by specialists, but it has not been widely understood. As a scientist put it the threats posed by the population explosion are so vast and so intractable that beside them the threat of a thermonuclear was pales into insignificance. To solving ecological problems will not appreciably affect the proliferation

factor. The efforts to-date to level off the growth curve have been perfunctory, mainly because men in authority are not yet fully seized of the implications of the phenomenon. Current techniques to contain it are sloppy; without coerciou little can be achieved in the time available. Many countries do not accord it a high priority, there is no global coordination or exchange of data; and, on an individual basis, there are not enough incentives. The problem is not so much of the figure-toting economists as that of the life scientist, the social psychologist and the administrator.

Today millions of people are utterly alienated, cities have been reduced to areas of chaos, resources are running out, and living standards stubbornly refuse to rise despite Herculean efforts. No wonder the problem is considered worse than nuclear bombs.

CHAPTER 17

FACTORS AFFECTING POPULATION DISTRIBUTION

The population of the world is very unevenly distributed over its surface. Nearly one-half of the world's population is contained within five percent of the total land area. In contrast, 57 percent of the earth's land area contains less than 5 percent of the world population.

Both ecological and cultural factors are involved in any explanation of the distribution of the people on the earth, but the great differentiations in population density can be explained to a large degree by ecological factors. Those factors affecting the distribution of population include the rainfall, temperature and relief features of the earth, water supplies, soil conditions, and location with regard to trade routes and world markets. In addition to the above mentioned ecological factors a number of non-geographical factors are also responsible for the distribution and accumulation of population in different parts of the globe.

The factors which determine the pattern of population distribution are as complex and varied. These factors may be grouped under three classes :

(a) **Ecological Factors**—including climate, landforms, soils, other physical resources and space relationships.

(b) **Cultural Factors**—including the attitudes and aims of the people, their economic activities and Techniques, etc.

(c) **Demographic Factors**—including the different birth and death rates of the various areas and the currents of migration.

ECOLOGICAL FACTORS

There is general agreement that ecological conditions such as the nature and degree of fertility of the soil, the configuration of the surface, climatic conditions, and spatial relations do affect the population distribution of the world. However, there is wide difference of opinion regarding the way in which the ecological elements operate in shaping the distribution of population.

Such geographers as Huntington[1] and Taylor[2] tended to view the ecological elements, particularly climate, as direct controlling determinants.

The Influence of Climate

Climate is the most important factor underlying the marked

1. Huntington—Civilization and climate, Chap. XVIII, 1924.
2. Taylor, G —Environment and Race, 1927.

contrasts in the density of population in different parts of the world. Climatic conditions limit the habitable area of the earth[1]. Climate also influences man indirectly by controlling the wide range of his life conditions dependent upon the plant and animal life about him.

Temperature

Among the ecological factor, influencing the density of population, temperature occupies a prominent place. A climate having suitable temperature has an invigorating influence upon the efficiency of man-both mental and physical[2]. According to Huntington[3]." Temperate marine climates with their stimulating and invigorating effects on the physiological and mental frame work of man are among the climates par excellence the best area for maximum concentration of human settlement". On the contrary a very high temperature like that of the Equatorial or desert regions and a very low one on the polar regions both are detrimental to human efficiency.

The density of population and the quality of population of the temperate regions of the world has much co-relation with the prevailing temperature. According to Vidal de La Blache[4]," Distribution of these early centres seems to be confined, approximately, to a zone bounded by the Tropic of cancer and the fortieth parallel of latitude". Of course, certain exceptions are there, in which temperature does not possess a primary status, rather it has secondly or subsequent importance. Tne Tropical regions, especially some parts of Indonesia are densely populated not because of suitable temperature but because of the political expansionist policies of the temperate countries. It is because of their political covetedness to acquire strategic position and valuable raw materials that the present Indonesian countries exhibit such a dense population. Extremes both of heat and cold reduce the density of population, the scale and efficiency of economic enterprises.

Precipitation

The best example of the relationship between population and

1. Blumenstock and Thornthwaite have pointed out that the patterns of climate, of vegetation, and of soils in various parts of the world coincide to a remarkable degree because climate is the fundamental force shaping the other two. Though man may vary his pattern of culture to a certain extent, he cannot go beyond the limits set by climate—climate and the world pattern, 1941, p 98.

2. Markhan—Climate and the Energy of Nations, p. 29.
Winslow and Herringaton—Temperature and Human life, pp. 254-55, op. cit. p. 392, 1924.

3. Op. cit , p. 392, 1924.

4 Op. cit p. 75.

rainfall is afforded by the Indo–Ganga plain of India. Fig. 17·1

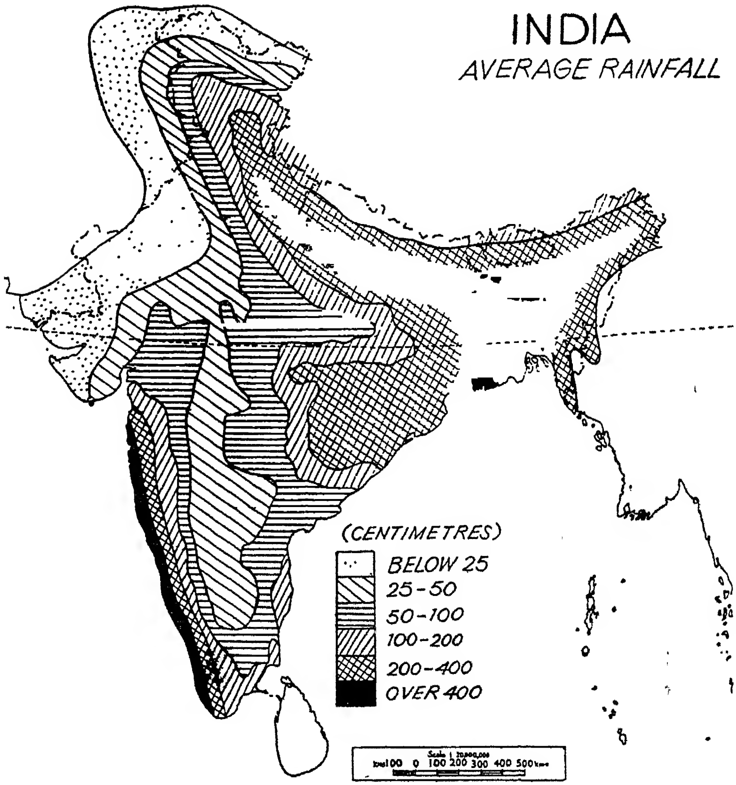

Fig. 17·1. Average Rainfall.

shows the average rainfall of India with relation to population distribution. Here the amount of rainfall goes on diminishing from east to west and with the decreasing rainfall the density of population goes on diminishing as shown in fig. 17·2. The relation between the amount of rainfall and population, in general, is universal. According to Brunhes, "Excessive rainfall, too, like a shortage of rain, militates against an excessive growth of population, so that the greatest and best development of humanity is found in the areas lying between these two extremes. It is always the intermediate zones that are the great cradles of population..."[1] In a few areas excessive rainfall may discourage human settlement, since high precipitation contributes to the excessive leaching of

2. Jean Brunhes—Human Geog p. 46.

the soil, to erosion, and to unmanageable forest growth. However, high precipitation is not generally regarded as a direct cause of low population density.

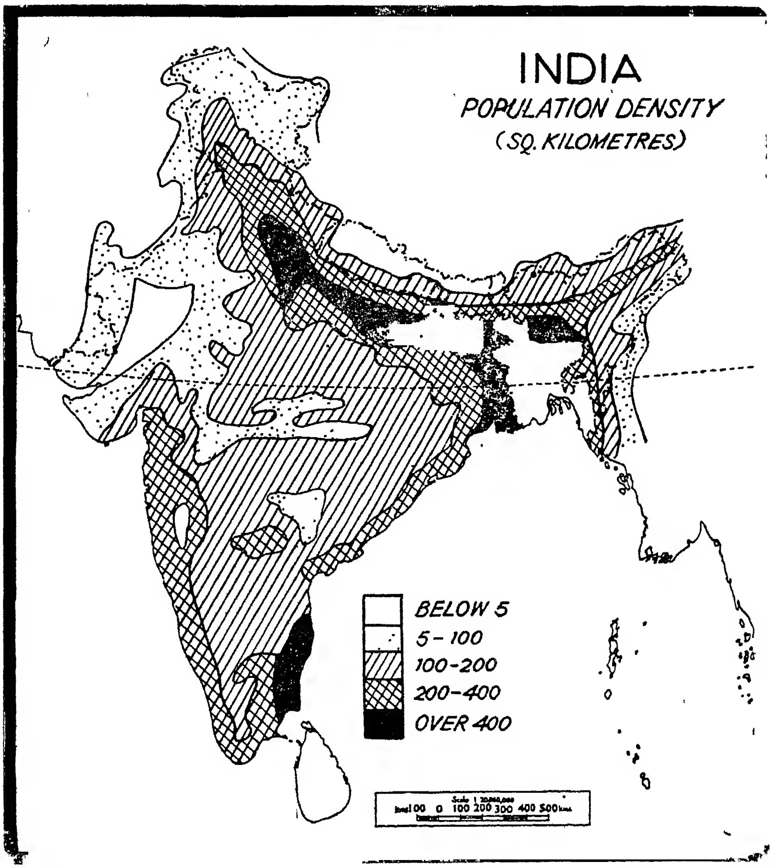

Fig. 17.2. Population density in relation to rainfall, see also fig. 17·1 (on district unit)

The Influence of Landforms

According to Miss Semple,[1] "Mountain regions are as a rule, more sparsely settled than pains." Generally, population is likely to be concentrated in small clusters in areas where the landform is hospitable. In the mountainous regions the soil is somewhat fertile but the soil erosion is very great, the climate is very cold, for these reasons with in hilly areas the cultivation of crops is done on a very limited scale, as a consequence of which the population is also very sparse. The population goes on decreasing with the increase of elevation. One of the best areas in the world for population has been estimated by Miss Semple on the basis

1. Semp. ibid, pp 360—61.

of elevations, and it will be useful to consider the chief elevated regions with a considerable population. According to Semple[1]. In the Trópical highlands of Mexico, central and South America, on the other hand, concentration of population and its concomitant cultural development begin to appear above the 2000 metre line. Here are the chief seats of population. Mexico has three recognized altitude zones, the cold, the temperate and the hot, corresponding to plateau, high slopes and coastal piedmont about 1000 metres, but the first two contain nine-tenths of the people. While the plateau has in some sections a population as dense as that of France, the lowlands are sparsely peopled by wild Indians and lumbermen. Ecuador has three-fourths of its population crowded into the plateau basins (mean elevation 2400 metres) enclosed by the ranges of the Andes Peru presents a similar distribution, with a comparatively dense population on a plateau reaching to 3300 metres or more, though its coastal belt, being healthful, dry, and fairly well supplied with irrigation streams from the Andes, is better developed than any other similar districts in Tropical America In Bolivia, 72 percent of the total population lives at an altitude of 1800 to 4200 metres, while five out of the nine most densely peopled provinces lie at elevations over 3300 metres".

In Europe the largest areas of heavy population occur in the Rhine and Po valleys below 180 meters and along the slopes of the Bohemian Highlands etc , at about 460 metres Only in Spain and Bulgaria there are many inhabitants above 900 metres. In Asia, the regions of close settlement in India are below 450 metres and in China below 900 metres.

Although the most striking evidence of the influence of landforms is to be observed upon the world pattern of population distribution between mountain-lands and plains, landforms are also likely to play a significant role in the distribution of population on a local scale. The chief deterrents to the peopling of areas of rugged terrain are :[2]

1. The very limited extent of arable land ;
2. the difficulty of maintaining existing arable land ;
3. the relatively high cost of constructing, maintaining, and operating agricultural equipment and means of transportation;
4. the isolation that is likely to exist ; and.
5. the adverse effects of altitude on human activities.

The Influence of Soils

The density of population in mountains is influenced also by the composition of the soil, which affects its fertility ; by the grade

1. Semple—Influences of Geographic Environment, pp. 526–560–61. 1911.
2. Ritchie, some observations on problems of hill and Marginal land, 1950.

and exposure of the slopes, which determine the case and success of tillage ; by the proximity of the high lands to teeming centres of lowland population, and by the general economic development of the people. The soil of the plains is fertile, has adequate facilities for irrigation, and can be made so, consequently the crop-yields are high. "Fewer economic opportunities present themselves to the peoples of the mountains than to those of the plains." In the plains the facilities for development of trade an commerce are to be found to a great extent. All these various factors make the plain areas capable of supporting dense population.

The Indo-Ganga plain of India, Hwang Ho valley of China, etc. are overcrowded since historic past. According to Blache,[1] "The great rivers in particular, descending from the High Asiatic massifs, and fed by seasonal rainfall, not only bring waters impregnated with soluble substances, they also deposit much alluvial material. One is almost tempted to guess that in the beginning the largest human settlements must have been located in the section of the lower valley, where the over burdened stream succeeded in depositing its load. As a matter of fact, are not some of the highest population-densities on earth found today upon some of the large deltas between the Nile and Yangtze......" In certain portions of the world, which have been zones of poor soils as well as high birth rate, the effects of heavy population pressure are especially manifest, and this may have caused the tendency towards the declining population, as vividly expressed by O. E Baker, "that wonderful Era of rapid increase of population, of the flowering of the spirit of freedom and individual initiative of agricultural expansion, of exploitation of the virgin soils and rich mineral resources of a continent, with the speculation inevitably associated with such exploitation, of unprecedented industrial and commercial development, of growth of cities, concentration of wealth, and rise of urban culture is drawing to a close". The attractiveness of a region to settlers may depend partly upon the quality of the soil. The soils of the world's grassland, particularly in the middle and sub Tropical latitudes, and those of the broadleaf forests in the middle latitudes generally favour relatively dense settlement. According to Kellogg, "the soils developed under grasses are the most productive for the ordinary crop plants under common systems of farming".[2]

Minerals

In areas where the minerals occur in great quantity, industries grow and attract the labours from other areas and consequently the density of population becomes very high. The availability of gold at Kalgoorile and Coolgardie has been cited as a partial explanation of the presence of thousands of industrial workers in the desert of Western Australia. The power of a mineral deposit to

1. Blache—Human Geog. pp 75–76.
2. Kellogg, The Soils that Support us, p. 105, 1941.

attract population depends on a number of circumstances including :

(a) the importance of the mineral as a raw material or source of energy for various types of production.

(b) the availability of the mineral at other places, the conditions affecting the cost of its production and efficiency of its utilization at each site and the attractiveness of each site from other points of view as a place of habitation.

Rivers

In areas where the rivers deposit fertile soils every year, the agricultural density of population is great, because the "fertility of that most productive section of the river valley that creates and maintains the greatest density of population."[1] In those rivers where the Hydro-electric power can be developed, there is vast possibility for the adjoining areas to hold dense population in the near future, because the truth of the matter is "that these great rivers have many different potentialities."[2]

CULTURAL FACTORS

Among the cultural factors which have been empha sized as having an important bearing on the distribution of population are the types of economic activities in which the people are engaged. The techniques of production, the form of social organization and the objectivess which the society seeks to attain.

Those factors affecting the distribution of population include the methods of agriculture and techniques, irrigation and transpot facilities and their form of social organization.

Methods of Agriculture

The density of population depends upon the methods of agriculture. If the agricultural methods are scientific, the yields are higher and the supply of food resources will be greater and in consequence the density of population will also be higher. In the Islands of Japan as well as that of Java the density of population is probably very high. The higher density of these Islands is attri buted to the fact that here the fertility of soil is great and the main crop of this region is rice. The population density of rice producing areas is comparatively higher, because, first, a certain quality of rice can feed more persons than the other crops ;

Secondly, the rice plants mature earlier i. e. in three or four months while wheal reaches maturity in five or six months. Hence three or four crops of rice can be grown in a year but if the climate is warm enough so tnat rice plants can quickly complete their cycle of growth ;

Thirdly, the per hectare average yield of rice is three times greater than that of wheat and twice that of barley :

1. Mukerjee M.—The Political Economy of Population, p 112–113.
2. Blache, op. cit., p. 77.

Fourthly, the rice agriculture requires a lot of human labour and hence it is cultivated in denesly populated areas of Monsoon Asia.

Java probably is the most densely populated island of the world. The total geographical area of Java is 131820 Km² with a population of 51·2 million, and the population density is 310 persons per spuare kilometre. Java's extremely fertile lava soil produces a wide variety of commercial crops to feed her increasing population, which is now probably growing by over 1·5 percent per year, despite a fairly high death rate.

In addition to the combined effect of various ecological factors, certain human factors are very important in affecting the birth rate and density of population in a given part of the earth. Infanticide is practised most frequently thus striking directly at the source of population. As Diamond Jenness observes "as late as 1916, during a rather severe winter, five Eskimo mothers around the westren end of Coronation Gulf, where the total population did not exceed four hundred, destroyed their babies within an hour of delivery."[1] Infanticide is very generally practised among Tikopian family. According to Dr. Rivers, "A Tikopian family is usually limited to four children, any in excess of this number being killed by burying them alive in the house or just outside it .... "[2] Among the Koko-Nor Tibetans, monogamy is the rule, polygamy the exception and confined to the few rich, while families never include more than two or three children.

Jordan and Bahrein recorded on average five children per mother. Equivalent European figure was two children and the US figure three children.

According to the view taken by most geographers at present, the distribution of population over the surface is not determined strictly by physical factors; the influence of these factors depends on the ways of life of the people. According to James "the significance to man of the physical features of the land is determined by culture ... . and therefore any change in the attitudes, objectives, or technical abilities of a people inhabiting an area requires a re-evaluation of the significance of the land".[3] It is generally agreed that the more complex a society becomes the less directly ecological factors influence the distribution of its population. The importance of these factors in modern times is less than it formerly was.

Lastly, it should be borne in mind that the pattern of population over the entire surface of the earth with her local and regional anomalies, is a function of variety of causes in which the ecological elements play a very prominent role, while the Socio-political and cultural forces are contributing factors of no less significants. It must be conceded that none of these factors is individually responsible for the disparity in population distribution over different parts of the globe and also that with the progess-

1. The Indians of Canada. Bull. 65, p 52 Ottawa, 1932.
2 Rivers. W.H R.—The History of Melanesian Society. Vol I, p. 313.
4 James—A Geography of Man, p. VII, 1949.

ive evolution in scientific civilization of present day, some of these factors will lose their significance.

DEMOGRAPHIC FACTORS

Demographic factors; including the differing birth and death rates of the various areas and the currents of migration. Changes in the distribution of world population take place through the medium of births and deaths in various areas and of migration between these areas. There is an obviovs relationship between births, deaths and the growth of population. Table 17·1 shows that birth and death rates for undeveloped countries are much higher than in economically advanced countries.

Table 17·1

Birth, Death and Natural increase rates of selected countries. (for various sources)

Country	Birth rate (per 1000 inhabitants)	Death rate (per 1000 inhabitants)	Natural increase (1000 inhabitants)
Africa			
Nigeria	49	13	36
Egypt	40	17	17
Congo	33	13	13
Algeria	30	13	13
Asia			
Iran	43	9	34
China (Taiwan)	41	7	34
Thailand	37	10	27
Vietnam	31	7	24
China	34	11	23
Indonesia	30	12	18
Phillippines	25	7	18
India	26	12	14
Japan	18	7	11
Pakistan	21	12	9
Europe			
Poland	25	9	16
Yugoslavia	23	10	13
Spain	22	9	13
Netherlands	21	8	13

Romania	20	10	10
Italy	18	9	10
France	18	11	7
West Germany	17	11	6
Czechoslovakia	16	10	6
U. K.	17	12	5
Hungary	15	10	5
East Germany	17	13	4
U.S.S.R. (as a whole)	25	8	17
North America			
Mexico	47	12	35
Canada	28	8	20
U.S.A.	24	9	15
South America			
Colombia	44	13	31
Peru	39	11	28
Brazil	43	21	22
Argentina	23	8	15
Australia (as a whole)	23	9	14

Migration as a factor of population distribution

The influence of migration on distribution and characteristics of the population is a subject of study which is of particular importance in understanding the demographic situation of the world. A detailed study of migration involves an understanding not only of the numbers of migrants and directions of their movement but also of their characteristics with respect to age, sex, occupation, etc. and the type of migration, e.g., whether transitory or permanent. Such detailed information is not available with respect to migration of the world.

In the 19th century, during the British rule in India a large number of Indian labourers went abroad in search of employment. They went South Africa, Fiji, Trinidad, Jamaica, Guiana, Mauritius, Sri Lanka, Burma and Malaya and worked there often under humiliating conditions. In addition, Indians also went to Burma, Ceylon, East and South Africa for trade and industry.

But many of these people, who spread out to other countries and had settled down there, had to come back for different reasons. The government of India had to give assistance to them in their efforts to resettle themselves in India. The repatriates who returned to India have mainly come from Burma, Sri Lanka, Mozambique and Uganda.

In 1963, the Government of Burma nationalised all import and export trade and internal distribution system. The work licences of Indian labourers were not renewed and the services of Indian employees were terminated. All these measures had led to a situation in which the Indians found it difficult to undertake any work or engage themselves in any activity in Burma. The Burma repatriates have gone mainly to Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Bihar and West Bengal.

Transit camps have been set up in Tamil Nadu, Orissa and West Bengal to provide temporary shelter and relief facilities to these repatriates. About 40 percent of the repatriates from Burma are petty traders and businessmen, 40 percent are labourers, 12 percent are agriculturists and the rest are employees, skilled workers, artisans etc. The rehabilitation facilities given to them include loans for trade and business up to Rs. 5000 per family and loans for construction of house and business premises.

Various measures have been taken to settle the agriculturist families under the land colonisation schemes in States like Karnataka, Madhya Pradesh, Tamil Nadu, Bihar and Uttar Pradesh.

Under the Indo-Ceylon Agreement of 1964, India has agreed to accept the repatriation of 5,25,000 persons of Indian origin in Sir Lanka together with the natural increase, over a 15-year period. About 90 percent of the repariates are plantation workers. Therefore, plantations for resettling these workers are being developed. These include a tea plantation in Nilgiri, a coffee plantation in Andhra Pradesh and a rubber plantation each in Tamil Nadu, Andaman and Nicobar islands, Karnataka and Kerala. There is a transit camp at Mandapam in Tamil Nadu which can provide accommodation for about 700 families.

As in the case of Burma repatriates, the Sri Lanka repatriates also get business loans, loans for house construction, business premises etc.

The Tamil Nadu and Andhra Pradesh governments have been authorised to resettle repatriates in agriculture under the land colonisation schemes giving up to Rs. 4500 per family, provided the value of the assets brought by the family does not exceed a certain limit. Repatriated families who return to cultivate their own land are also given financial assistance for land development and cultivation costs depending upon the size of the land holding.

Roughly the total number of people of Indian origin abroad is about 5 million. Table 17·2 shows the number of people of Indian origin in countries where their number one thousand and over.

Table 17·2

Number of Persons of Indian origin Abroad.
(From various sources—in Commonwealth countries)

Name of Country	No. of Persons of Indian origin
Aden	15,817
Australia	2,500
British Honduras	2,000
British Guina	2,10,000
Br. North Borneo[2]	2,000
Brunei[2]	2,000
Canada	3,750
Sri Lanka	829,619
Fiji Islands	169,403
Grenada	6,000
Hongkong	2,500
Jamaica	26,000
Kenya	1,27,000
Federation of Malaya[2]	7,40,436
Mauritus	3,75,918
NewZealand	1,800
Nyasaland[1]	6,000
Rhodesia[1]	9,200
Sarawak[2]	2,000
Singapore[2]	98,267
South Africa	3,65,524
St. Lucia	3,000
St. Vincent	2,000
Tanganyika	68,000
Trinidad	2,67,000
Uganda[3]	50,000
Zanzibar and Pemba	15,812

Other Foreign Countries

Bahrein	3,000
Congo Republic	1,227
Burma[4]	7,00,000
Dutch Guiana	70,000
Ethiopia[5]	1,645

Malaysia	2,300
Indonesia	30,000
Somaliland	1000
Kuwait	2,500
Madagascar	14,000
Nepal	10,441
Phillippines	1,675
Mozambique	12,600
Ruanda Urundi	1,963
Saudi Arabia	5000
Sudan	2,000
Thailand	10,000
U.S.A.	5,063

Note : 1. Approximate, 2. also includes Pakistanis, 3. Latest figu es not available. 4. Estimated. Source : Censuses of population for 1951, 61 and 1965 and other published reports

The migration of races, caused by overpopulation and economic wants and attempts to escape from exploitation and persecution has led to the further windening of the area of conflict. The population and race problems as we know today are the results of migration and contacts of peoples. Race conflicts are among the most important factors of political and social unrest in the contemporary world and their significant increase as racial feeling. Historically, such conflicts had their origin in the migration of races and in the conquest of territories already inhabited by other races.

It has been observed that the areas of greatest population density of the globle are those combining a great variety of economic productivity. Within limits men can make their own decisions regarding the places which they will inhabit and the political state may influence the size and internal distribution of the population in the area which it controls. The distribution of population is thus affected by the objectives which the society strives to achieve and by the forms of social action which are taken to achieve those objectives. Population has unquestionably been affected to an important degree by the efforts of governments to control migration across international frontiers.

CHAPTER 18

THE DEMOGRAPHIC CYCLE

Demographers have revealed a remarkable correlation between the progress of industrialization and population growth. This has resulted in the theory of the population cycle, a definite pattern of population progression that has been standard for industrial nations. The Demographic or population cycle can be reckoned from the standpoint of the socio-economic history of a country. This criterion can be applied to gauge the demographic history of an advanced country. Taking Great Britain as an example, she stood in the first phase of demographic cycle prior to the industrial and agricultural Revolutions. With the approach of Industrial revolution better sanitary conditions were brought about together with the rising living standards as a result of emigration, colonization, greater production and greater consumption, she stepped into the second and subsequent phases, with the help of scientific and industrial development.

The demographic cycle is applied to the whole world, various nations cut the cycle at different stages, mainly based on the population growth and industrialization of different countries. If the statistical data of the population growth of various countries be studied, the conclusion reached is that are five stages of population growth which are termed as Demographic cycle. According to the growth of Demographic cycle the world population can be divided into the following sectors.

The First High Stationary Phase

According to O. E. Baker, "a stationary population is probably the most desirable condition, for one reason because a large proportion of the population is in the productive age group—20 to 60 or 15 to 55 years of age than in an increasing or decreasing population"[1]. The countries in this phase of development are marked by high birth and high death rates. In this category countries are included such as Tibet, Indonesia, Ethiopia, Iran, Arabia, Afghanistan, China etc. and countries of South America.

The major portion of the population resides in villages and their economic development and improvement of its living standards, thus depend largely upon the growth and progress of the agricultural sector of economy. A good and bad harvest depends on the abundance of rainfall or the absence of it. The rain in plenty makes the per hectare yield of agriculture high.

1. O E Baker, Significance of Population Trends to American Agriculture The Milbank Memorial Fund Quart Vol. XV, p. 122.

The higher yield means the abundance of food resources. Therefore, the capability of land to hold dense or otherwise scanty population depends on the equality of rainfall. But the density of population does not remain dense even if the rainfall is heavy. This results in bad crops, and the yields are low. Flood, diseases etc govern the high death rate.

China is the important country of this group, as Dr. Warrens S. Thompson[1] points out, "It seems reasonably certain that the birth rate in China is not over 40 and my belief is that it will average at least as high as that recorded for Formosa (45·6) and possibly even higher. The data on the death rate are even less consistent than those on the birth rate but seem to justify the statement that the death rate seldom falls below 35 and then only under conditions quite exceptional in China, such as in a smaller area where there is some health work in a good year when the harvest is abundant and epidemic disease is mild. The death rate in China is highly variable from year to year and from place to place...The violent fluctuation, much more violent than the fluctuation in birth rates, is probably characteristic of all populations which, like that of China, have practically no health service and like close to the subsistence level, even in good years".

The countries within this group are Turkey, Burma, Sri Lanka, Pakistan, Madagascar, Egypt and Mexico, etc. Besides this, the countries which come within this phase were formerly under imperialism and colonial rule, such as Indonesia-formerly under Dutch rule, Formosa and Korea formerly under Japanese control ; Indochina-under French influence and Malaya formerly under British rule. We have seen that the pressure of population is not evenly distributed. Large areas of land are lying devoid of human settlement, whereas some very small parts are thickly populated. This unequal distribution of human stocks always seems the root of many political, economic and social problems. To some extent imperialism and colonialism are the results of this uneven distribution of human stock over the globe. Although with the passage of time the imperialism and colonialism have gradually vanished, but the problem of over population is still actually facing many developing or semi-developed countries. Every country willing to establish the relationship between her increasing population and available natural resources. The economic systems of the countries in the second phase are characterized by improved agricultural methods, with the introduction of irrigation facilities and flood control measures. These countries are so densely populated that human effort has exploited to the maximum extent all the natural resources and has reached the optimum point of population and now they are entirely beyond that point. Slight industrialization has also begun and few technical training also provides the labours

2. Thomson, An Experiment in the Registration of vital Statistics in China on Population and place in the P cific pp. 180–181.

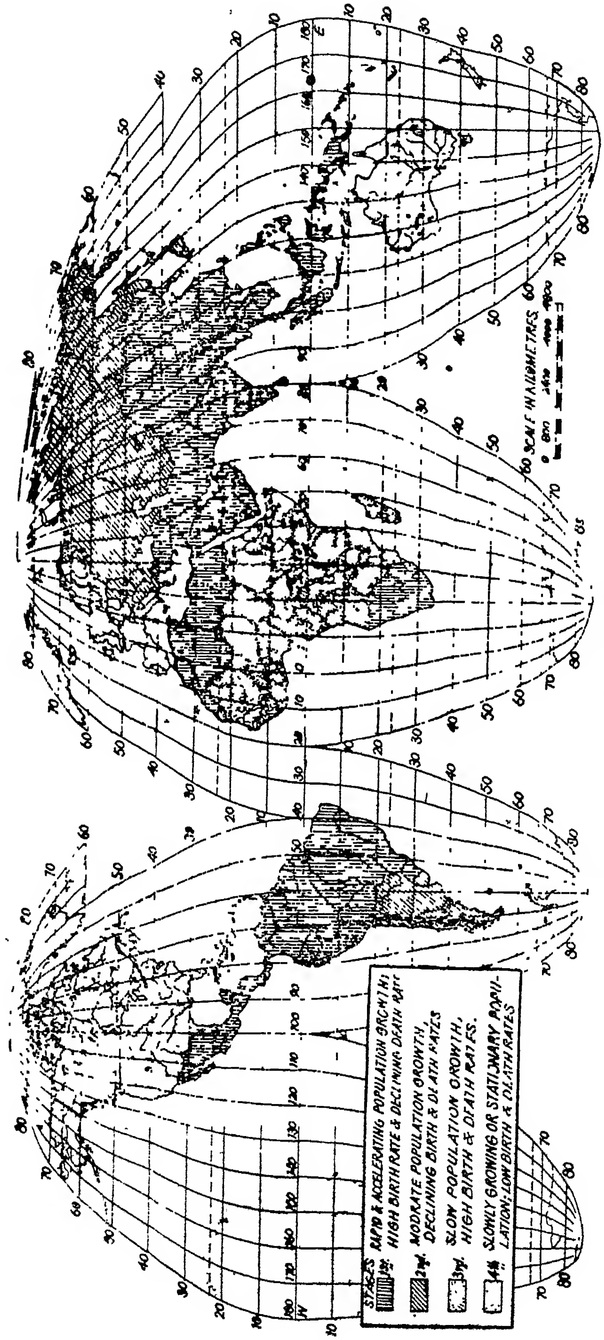

Fig. 18 1 Population Cycles (after Julian Huxley)

for scattered industrial establishments. It is also called the "early expandence" in which the birth and death rates range about 40 and 45 per thousand.

The Indian Republic is the typical example of the second phase of Demographic cycle. The history of industries and commerce in India is rather recent and the initiative provided by the Indian Government in the form of five year plans, is gradually tending to make the country more and more industrialized. India is determining to establish optimum population in order to increase the nationl dividend to the highest possible level. Birth control is one of the most important solutions to prevent the over population. Besides this brith control is necessary in the "interest of social economy, family happines and national planning, family planning and a limitation of children are essential. The prospective role that birth control, along with the mechanised farming and industrial development, is expected to play a important role. The Government of India appointed in 1950 the Planning Commission, which points out, "while family planning is intended to bring down over a period of time the rate of population growth, immediately it is a step in the direction of improvement in heaith, especlally of mothers and childern. Frequent and ill spaced child births undermine the health of the mother. A high birth rate under conditions of poverty and malnutrition is inevitably connected with a high rate of infant mortality and a high incidence of disease and deformity among children. In planning for a rising standard of life, the provision of a more healthy and joyful existence for children in the formative period of their life is a matter of great importance."[1] It is, therefore, apparent that population control can be achieved only by the reduction of the birth-rate to the extent necessary to stabilize the population at a level consistent with the requirements of national economy, This can be secured only by the realisation of the need for family limitation on a wide scale by the people. The main appeal for family planning is based on considerations of the health and welfare of the family. Family limitation or spacing of the children is necessary and desirable in order to secure better health for the mother and better care and upbringing of children. The recent increase in the population of India and the pressure exercised on the limited resources of the country have brought to the forefront the urgency of the problem of family planning and population control.

The Third Phase

The third phase of Demographic cycle is applied only to the countries such as the Soviet Union, Japan, Italy, Spain, Poland, Argentina, Chile cte. In this phase come those countries, where the birth rates rangs between 30 and 35 per thousand and death rates rangs between 20 per thousand. The most important country

1. A Draft outline of the first Five Year Plan, pp 206–207.

of the third phase is the U. S. S. R. "The Russians are probably at stage three of the population cycle and are multiplying about as fast as the United States."[1] The population increased from 147 millions in 1926 to 170 millions in 1939 and 187 millions in 1945. These areas are the newly inhabited like Siberia, but with the passage of time, it is hoped, they will also become highly populated countries, if the present rates of fertility and mortality continue. According to G. Taylor, "the birth rate of the Russians is very high, so that the population is expected to double itself in the next forty years. The forecast of 340 millions of Soviet citizens by 1975 is quite likely to be realized."[2]

The next most important country of this group is Japan. In Japan, although the population is not great but taking into consideration its total area it is higher and consequently the population density here is higher than other countries. It was officially stated in 1940 that "if the Japanese are to be leaders of Asia, they must expand greatly in number" and the practice of birth control must be driven out, the importance of family and race inculcated and early marriages and plenteous child bearing encouraged". But after the defeat of Japan on Pearl Harbour in 1941, the Tokyo newspaper—*Japan Advertiser*—announced, "The cabinet is expected today to approve a plan jointly advanced by the Welfare Ministry and Planning Board to establish a policy to ensure a sufficient population for the further development of the Japanese race At present Japan proper has a population of 64,058,000 which the Welfare Ministry and the Planning Board would increase to 100,000,000, by 1960. Since the present birth and death rates do not insure such a population, the plan aims at reducing the present marrying age of 27 for men and 24 for women, to 24 and 21 respectively. The new standard will make it possible for an average couple to have five children, it is expected." Before the present tremendous industrial development, the population of Japan increased very rapidly, that is not only doubled itself but also created an enormous number of surplus population for emigration to other countries. But now the condition has become opposite specially in areas where industries and commerce have become the sources of livelihood rather than agriculture. Besides this, when Japan lost her territories such as Manchuria, Korea Taiwan and as a result of her defeat in World War, II her economic dominance and soundness collapsed, particularly in the sphere of foreign trade. The Japanese defeat also had wide repercussions on her demographic pattern and the equilibrium between her population and the resources was disturbed, posing a serious problem of over population and the resultant deterioration in the standard of living.

One of the effective remedies to step up with the incresing population in Japan is to increase the agricultural production

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1. Taylor, G., Environment Race and Migration, p. 445.
2. Op cit.

through modern techniques and intensive cultivation of land. "Japan is the country where the stones show human finger prints, where the pressure of men on the earth has worm through the iron rock. There is nothing in Japan but the volcanoes and the volcanic wastes that men have not handled. There is no getting away from men anywhere; from the sights of men in the open houses or from the shape of their work in the made fields or from the smell of their dung in the paddy water."[1] The only remedy is to improve Japanese agriculture or to add more land. But this is not all. Land is not available on the Islands. Industrialization is often offered as a stock remedy for Japanese population problems, "Japan does not look to emigration to solve her population problems, but to a further industrialization of the country, so that this increase in the number of people in Japan will become not a reason for war, but a means whereby international trade will be increased and a hope for a continental peace strengthened."[2] The chances of industrializing the country rapidly are scarcer as compared to the conditions of the pre-war years. Japan no longer remains the colonial power and the countries possessing raw materials in the Far East and South East are themselves striving hard to industrialize and use their raw materials as one of the foundation stones of industries.

The Fourth Phase

The fourth phase of population cycle is more "advanced and involves less wastage of human resources." In this phase come those countries where the birth and death rates are very low and the countries within this phase of population cycle are the United States, Norway, Great Britain, France, Denmark, Germany, Hungary, Belgium, Austria, Sweden etc.

The U.S.A. has 207 millions (1971) people and is growing by 1·8 percent per year, but its total resources, are sufficient to ensure a constantly rising standard of living over the next generation. The economy of these countries is expanding very rapidly on the basis of vast natural resources. The government is playing an important role in the various forms of economic and technical assistance.

In the above mentioned countries the birth and death rates are very low. In all European countries, the decline in birth rate received a slight check during the world war II. But there was a sharp rise in the number of children born after the second world war, the birth rate and death rate soon became stable, due to "more deaths and fewer births," resulting in a small and steady growth of population. In brief, those European countries with declining birth rates are willing to allow their able citizens to emigrate. As Dr. Julius Isaac admitted that the emigrants of high birth rate to sending declining birth in European countries has raised the population. He points out, "Before the out break of the 1939 war, it seemed probable that the agricultural states of

1. Archibold Maclish. Japan Fortune. Sept. 1936.
2. Editorial, Japan Advertiser, Dec. 1940.

Eastern and South Eastern Europe – the main source of the new emigration since about 1880—might in the near future expect a large natural increase in population, in spite of their falling gross reproduction rate, from a fall in the death rate due to a steady improvement in social conditions and death services. As the population of these countries has been hard hit by the devastation of the world war II, these expectations will scarcely materialize soon after the war. It may, therefore, be safely assumed that a change in mortality will not significantly after the prospect of population decline in Europe."[1]

Switzerland is a representative country that has built a high standard of living with a population that is dense in relation to its cultivated area and with only water power and scenic beauty as natural resources. The other factor is the good location in relation to other countries which is favourable to industries and commerce. Coal and iron, the foundation pillars of modern civilizaation, are found in abundance in Europe. Besides these two fundamental minerals, others also occur there. The climate is favourable for physical exertion. These factors combined together helped the early growth of industries in these countries. On the other hand, North Eastern United States also possess the same locational advantages as Great Britain and other European countries.

The Fifth Phase of Population Cycle

The fifth and the final phase of the population cycle is characterized by an actual decline in the total population of a conntry by means of an excess of deaths over births. A perusal of the world's population indicates that such situations arise not so much of an excess of high death rates over the birth rates as through a considerably low birth rate. The effects of such trend in population growth tend to be serious, when such a phase becomes permanent. The remedy lies in giving a stimulus to increasing birth rates and greater volume of immigration. Under such depopulation trends, the danger of a kind of "race suicide" is likely to come into force, but it does not imply the total disappearance of a human stock from certain parts of the earth.

The demographic cycle in respect of various countries of the world as explained by Dr. Blacker "The depopulation of islands such as Tasmania, where none of the original native inhabitants survive, or the Tropical Oceania where they have been much reduced ; or the disappearance of native races from areas of a continent, as the North American Indians have disappeared from many of their original hunting grounds, are to be counted rather as a reaction to the spread over the globe of the white man than as an autonomous phase in a demographic cycle. In recent times, France is the only country which has experienced an actual excess of deaths over births for more than a momentary period ; and there are signs that perhaps, as a result of very energetic

1. Julius Isaac—Economics of Migration, pp. 80—81.

measures taken since the end of the second world war, this trend is being reversed."[1]

In the above mentioned quotation Blacker includes France in the final phase of population cycle due to excessive death rates over the birth rates. Three most important effects of this decline are note worthy ;

Firstly, the slow growth of the French population in the end of the nineteenth and beginning of the Twentieth centuries.

Secondly, the decline of French fertility was on age structure ; old people became more numerous in relation to the young.

And, thirdly, the Social Philosophy that is to say the control of celibacy, the postponement of marriage, the spread of "coitus interruptus and the widening practice of abortion are thought to have contributed to the decline."[2] The combination of high mortality and low fertility caused a continuous excess of deaths over births.

The population cycle looked from the purview of total world population at a certain given time stands in different stages in different countries of the world. The harmony in the stages of demographic cycle does not, and as a matter of fact cannot, exist in the population of different nations.

1. Blacker, C. P.—Stages of Population Growth, 1948.
2. PEP, Sept, 1955, pp. 199—220.

CHAPTER 19

DISTRIBUTION OF POPULATION

If a glance is set on the population distribution map 19·1 of the world we will find that the population of the earth is very unevenly distributed. One fourth of the land surface holds approximately 90% of the total population of the world. The remaining 10 percent is very thinly distributed over 75% area of the earth, most of which is too cold or arid for agriculture.

The four principal regions of dense population on the earth are :

1. **Eastern and Southern Asia**—including India, China and Japan, which contains over half the world's total population.

2. **Western and Central Europe**—a fourth of all population, 500 million, occupies an area which amount to roughly 6% of all land.

3. **South Eastern Canada**—majority Canadian settlements were within 1000 kilometres of Montreal, and only a few were as far away as 1500 km.

4. **North-Eastern United States**—Each country of the South-eastern Canada and North eastern United States of North America has a very patchy population distribution with the bulk of its population localized on a small proportion of its total area.

These four regions, with only one tenth of the land surface of the globe, sustain two thirds of the earth's people. In all these four zones the density per square kilometre exceeds 300, but there are many local variations. In Yangtze valley the density is 700 persons per square kilometre, in Hwang Ho valley it is 600; and about 400 per square kilometre in the Ganga delta. The present unprecedented increase in human numbers is not a process which is going on equally all over the world. In spite of excessive density of population in certain regions about half the total area of the earth is now empty space. In certain regions the density is below 2 persons per km^2. These are : Hot deserts, Equatorial regions, Mountains and Plateaus of Central Asia and Sub-polar areas. The problem of scarcity in over populated region can best be solved through migration of people to open spaces. Fig. 19·1 shows the population density of the world.

Population Distribution in Asia

The distribution of population in Asia is unique unlike the distribution in Europe, it is unevenly and unequally distributed. The great human agglomerations in Asia cease at about the same

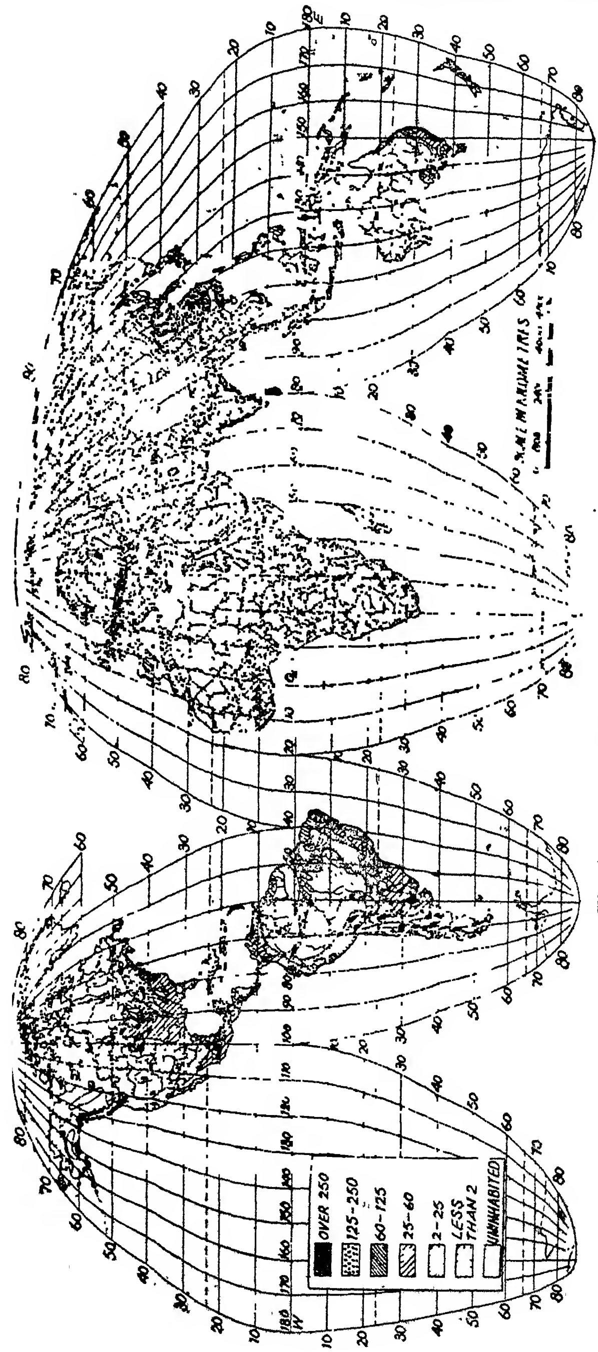


Fig. 18·1. Population Density in km^2.

latitude where they begin in Europe. According to Blache[1], "the Asiatic agglomerations were created and have grown up under the influence of one dominant cause, that of the Monsoons. Centres of dense population—scattered at first – have generally approached one another and finally merged,.........the various contributing causes are sunlight, rivers and rainfall, all of which relentlessly over-stimulate the productive soil". Some parts of Asia have densest population such as Java, whereas in other parts like Tibet are very very thinly populated. In Siberia the density is fourteen persons per km^2 , is generally known as the "Store house of the future". In Middle East some parts in Arabia have only one person per km^2 and have many potentialities for future growth.

Asia in its one-third portion contains three fourths of its total population. All the plains of Asia are densely populated. Such contrast in density is not experienced in any other continent. There are certain reasons of this unequal distribution of population and the first cause of all is that the continent of Asia is agricultural. Therefore, the people concentrate only in those parts where the land is fertile. All the river plains where the soil is fertile, irrigation facilities are available, means of communication are developed, are densely populated. The Indo-Ganga plain of India, Sikiang Yangtze Kiang in Peoples republic of China, and Kwanto plain in Japan are densely populated regions of Asia.

All the eastern half of Asia is drained by rivers which flow towards South and East. All these plains tend to make this South-Eastern part of continent is the most densely populated portion in Asia, and probably in the whole world.

The most important ecological factor which determines the distribution of population is climate. Those parts of Asia where the rainfall is enough for the growth of grains are inhabited by people. But on the contrary, where the rain fall is less than 50 cm. these parts are sparsely populated. Such parts are in the interior of the continent. Mongolia, Turkistan, Central Siberia, Northern Manchuria and Northern Japan are such regions where the population is found very sparse. In the South East Asia Monsoon brust with their utmost capacity and greater part of their moisture is downpoures here. The rainfall is one of the most important ecological factor in determining the distribution of population. In western or Middle-East Asia, Arabia, Iran, Iraq has rainfall below 25 cm. and so that the population is negligible. The Middle East is often taken as the desert because the major portion is arid. But the valley of Euphrates and Tigris are again a populated area.

The next ecological factor is physical features. The high plateaus and mountainous regions are left desolated in spite of the mineral resources. It is only due to the lack of communication. The Shan plateau, the mountains of China the Pegu Yoma and

1. Blache, op cit., p. 116.

Arakan Yoma sparsely populated though there are mineral resources. The last factor in that there is lack of mobility in Asiatic peoples. People do not wish to go to some other land leaving their parental land. They are most conservative and believe in idol worship. Chinese say "who will worship the graves of our ancestors" if they go away to some other lands.

So these are some factors that lead to the unequal distribution of population. Some parts are over populated and some are underpopulated. With this unequal distribution there arise several problems. Underpopulated areas are very backward. The people are few and due to lack of labour no progress is possible Tibet—there are no means of communication no industries neither any social development nor economic development. The people of Shan plateau are still in primitive stage. In central and in some western part of Asia there pervades monotony. There is no vitality in the life of people. People of Central Asia are nomades. They have less economic activities. Natural resources are not used to the utmost capacity. And to use them it often happens so that foreigners enter and established their industries there to explore the natural resources Tibet is exploited by Chinese In Middle-East due to lack of technicians and technical knowhow, the mineral oil is explored by foreigners. Foreigners make their holding more and more strong day by day, when they settled in a underpopulated country. Tibet and Mongolia have been exploited by China only only due to the underpopulation. They had no military force. On the contrary, China a nation of over 700 millions people has greater man power than any other country.

Iraq is a small country possessing three vital resources—oil, water and land. Generally is known as a country of retarded development. In 1951 the Anglo-Iranian oil company was nationalised by the Iranian government. Britain withdraw all technicians and experts, the result being that the production of oil gone under an abrupt reduction from 129 million barrels to 9 million barrels. Complexity of geographical conditions and interplay of widely differing influences explain the anamalies and problems of population in the Middle East South west Asia is a bridge and a barrier between East and west, so that the positional factors are of great importance and, with the oil resources of these lands of backward technique, are responsible for the conflict of interests of great external powers of this area—national interest which restrict real independence of the several small states into which is divided. There are resources and the policies of nations their own.

Turkey is a miniature continent and its population is mostly distributed along the rims of Anatolian plateau may be described as a province of transition between Asia and Europe.

No country can make any industrial progress until and unless there is cheap and efficient labour and resources. But overpopulation is also a curse for a country.

China is a vast country. If occupies about 9·9 million sq.

kilometres. It stretches from east to west for more than 4000 kilometres and only a little than this distance from north to south. The population amounts to something between 600 and 700 million. Three-fourths of the area consists of mountain ranges, which are hardly, it at all, suitable for agriculture, and here the problems of soil erosion are acute. Millions of hectares of mountainous areas have become eroded to such an extent as to be no longer cultivated. The area subject to erosion aggregates over 1,500,000 km². Another large part of China is occupied by virtually lifeless deserts.

The principal agricultural regions and the larger part of the population are confined to the deltaic alluvial plains along the Pacific coast. Here is the world's highest population density, commonly reaching 3000–4000 people per square kilometre, and in some places ever more than 500 persons per square km.

There are a number of reasons why the population has not overflowed into the sparsely settled lands that surround the coastal and central provinces of China. Nature provides the most important reason. The settled areas are singed by regions of non-productive soils with either insufficient rainfall or unsuitable topography or both, areas of intense summer heat, or of long winters with only relatively short growing seasons.

The result of all these ecological factors which effects the density pattern of population, that is highly unbalanced, with such extremes as the Chengtu plain in Szechwan province, where the population density approaches over 1500 per square kilometre, and vast areas of Sinkiang, Tsinghai and Tibet, which are virtually unpopulated. According to Leo A. Orleans, the uneven distribution of the population is the fact that if a straight line is drawn from Ai-hui in Heilungchiang Province to Teng-Chung in Yunnan Province, only 40 percent of the land area of China lies southeast of this line, but 96 percent of the population lives there. Fig. 19·2 shows the population or whole Asia and China.

Volume of Overseas Chinese

The compilation of the total number of overseas Chinese is not an easy task. Since the countries take their official censuses at different times and intervals, it is extremely difficult to determine accurately the number of Chinese abroad in a particular year. Some countries use the criterion of ethnic background to define minority groups, others use nationally or citizenship.

Although there are Chinese in almost every country, they tend to be more numerous in the Tropical regions; in fact, about 97% of the overseas Chinese make their living in the areas between the Tropic of Cancer and the Tropic of Capricorn. The majority of overseas Chinese are found South of 18°N. The parallel that passes a few kilometres South of the island of Hainan. Besides the extremely dense Chinese population in South-east Asia, minor concentrations

occur in other tropical areas, notably in islands and countries bordering the Caribbean and on the islands of the Indian ocean and South Pacific. An overwhelming majority of the Chinese abroad, about 96·6 percent are in Asian countries. The overseas Chinese are shown in Table 19·1.

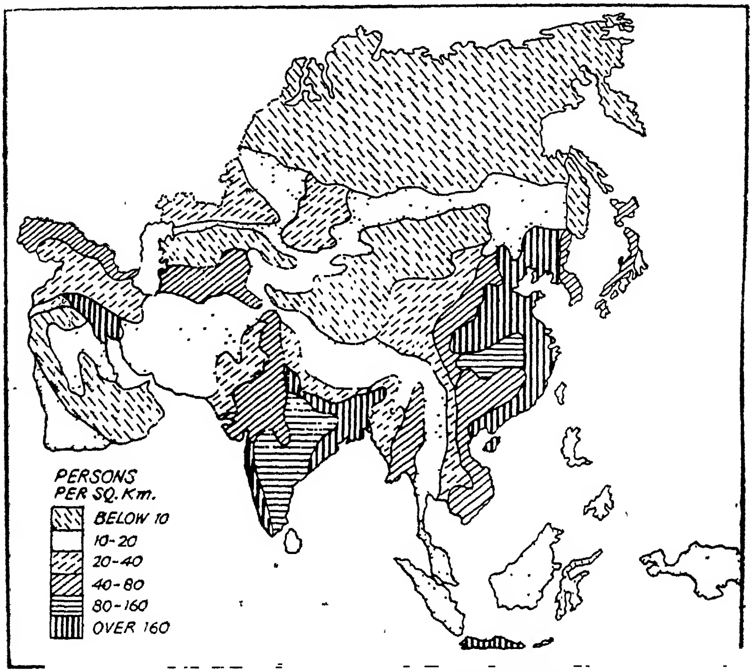


Fig. 19·2. Population density of Asia.

Table 19·1

Distribution of overseas Chinese (various sources)

Asia	15,859,820	96·58%
Thailand	3,799,000	
Hongkong	3,197,081	
Indonesia	2,545,000	
Malaya	2,461,322	
Singapore	1,302,500	
Vietnam	1,035,000	
Burma	450,000	
Cambodia	260,000	
Sarawak	229,154	
Macao	160,764	

Philippines		151,759	
N. Borneo		104,855	
India		53,252	
Japan		46,858	
Laos		24,360	
Korea		23,575	
Brunei		21,795	
Saudi Arabia		10,000	
Timor		5,113	
Turkey		3,300	
Christmas Island		2,100	
Pakistan		1,700	
Ryukyu		785	
Sri Lanka		450	
Jordan		40	
Afghanistan		28	
Iran		14	
Iraq		9	
Lebanon		6	
Oceania	**5,2572**		**0·32%**
Australia		19,800	
New Zealand		9,500	
Society Islands		6,948	
New Guina W.		5,000	
Fiji Islands		4,943	
New Guinea		3,000	
New Britain		2,000	
Nauru		800	
Samoa		301	
Soloman Islands		200	
Ocean Island		80	
Africa	**43,734**		**0·27%**
Mauritius		23,266	
Malagasy		8,901	
South Africa		5,105	
Reunion		3000	

Mozambique	1,735
Tanganyika	522
Angola	500
Rhodesia & Nyasaland	303
Kenya	150
Uganda	70
Zanzibar	70
U.A.R.	27
Liberia	27
Congo	24
Ethiopia	18
Morocco	11
Cameroon	3
Nigeria	2

Europe	**20,586**	**0·13%**
Great Britain	12,000	
Netherlands	2,400	
France	2,000	
Soviet Union	1,236	
Denmark	900	
Germany	800	
Italy	313	
Belgium	300	
Spain	210	
Portugal	143	
Czechoslovakia	96	
Poland	88	
Austria	30	
Sweden	24	
Luxembourg	20	
Greece	12	
Switzerland	11	
Norway	3	

Latin America	**148,709**	**0·91%**
Cuba	31,039	
Peru	30,000	

Jamaica	18,655	
Trinidad	12,000	
Mexico	10,000	
Brazil	6748	
Surinam	5700	
Guatemala	5234	
British Guiana	5000	
Equador	4171	
Costa Rica	3000	
Nicaragua	3000	
Panama	2960	
Chile	2950	
Venezula	2580	
Colombia	1400	
Dominicon Republic	1060	
Honduras	817	
Elsalvador	515	
Aruba	486	
Curacao	443	
French Guiana	308	
Argentina	240	
Haiti	204	
Uruguay	152	
Bolivia	35	
Paraguay	12	
Anglo-America	**295,489**	**1·79%**
United States	237,292	
Canada	58,197	

Will world provide any out lets ? But the International Famine Relief Commission, after explosing various possible solutions, for the Chinese population problem, pointed out that "if other nations open wide their door to Chinese emigrants, if all the ships engaged in intercontinental passanger traffic on the seven seas were with drawn from their usual routes and devoted themselves henceforth solely to transporting Chinese from their native land to other countries it is believed that they could not keep pace with the year by year increase of population."[1]

Japan participated in the II World War not due to political

1. China International Famine Relief Commission, Annual Report, 1929.

problem but also due to the over population. Most of Japan is mountainous and agriculture is carried on only in 16% of the total land area of the country. The level land area is mostly confined to the Eastern coast of Japan. On the Eastern plains of Japan are located the great industrial centres such as Tokyo, Yokohama, Kobe-Osaka-Kyato industrial regions. Here is found about one-half of Japan's population. Japan's solving her increasing population problem by establishment of industries and trade.

With the loss of Bangla Desh Pakistan's population has been reduced from 128·43 million to 58·4 million and it has suffered a territorial loss of 143,327 km². As against 840,375 km², its area now is only 697,048 km².

An interesting aspect of the population structure that has occurred as a consequence of the emergence of Bangla Desh is that there will be more Muslims in India than in Pakistan. Earlier it had a Muslim population of 93·7 million but now it will be only 42·8 million as against 60 million in India.

Sri Lanka's population is 12,900,755, according to the latest census, announced by the Department of census and statistics, 1973. It represents a 20·5 percent increase since 1963 when the last census enumeration was done by way of sample survey. Districtwise Colombo has the highest population with 7,699,392, representing a 22 percent increase in eight years followed by Kandy in Central Ceylon with 1,199,977, a 15 percent increase.

Citywise Colombo records the highest population with 563,705 followed by Dehiwala, a suburub of Colombo, with 154,313, and Jaffna, the capital of the predominantly Tamil-speaking northern province, with 106,856. Five other cities have population ranging from 50,000 to 100,000.

In contrast to these densely populated countries, the South Eastern Asian countries such as Malaya, Burma, Indonesia etc. Contain moderate densities per square kilometre. Burma is the most furtunate and thinly populated country of Asia. According to the census of 1971 the population of Burma was 28 million. The population pressure in south east Asia is not so great on the cultivable land, excepting Java.

The island of Java is densely populated, and sometimes the density of population is over 800 persons per km². One reason for this dense population of Java is the fertile volcanic soils. Secondly, the Dutch colonizers made it their colony and developed plantation agriculture on the basis of local cheap labour. Although fragmentation is the Keynote of the topography of south east Asia but demographically a compact block of comparatively high density.

The western immigrants came and settled there permanently; crop yield per hectare was increased by the use of scientific techniques and agricultural implements. The climate is favourable for the crops especially for sugar cane cultivation throughout the

year. Several other crops, along with rice, are grown on the same field.

If we compare the dense population of Java with the sparse population of Malaya, we find some cultural facts lying behind this unequal distribution. Plantation agriculture is the main factor to concentrated dense population in Java. But in Malaya, the aim of westerners was not to settle there permanently but only to gain their economic end by the maximum exploitation of natural and human resources of that country. Other countries in the South east Asia are still in various stages of economic development and political revolution.

In 1700, Russia's population of about 20 million was concentrated in the area that is approximately the central industrial region of today. The subsequent dispersion occurred by migration to the South, to the Volga area, and; ultimately, across Siberia. It is not by accident that in 1939 the mass of the Soviet Union's population lived in a broad triangle which had its base along the western border of the country and its apex in the Urals. A ecological map would reveal that this is the area comprising the steppe—which has fertile black-earth soils and, with certain exceptions, adequate rainfall—decidous forests. Below this triangle, in Central Asia, are the dry steppe and semi-deserts. Above it, in the north, are the coniferous forests and the frozen Tundra.

The direction and intensity of population movements in Russia were determined by the possibilities for agricultural development. Industrialization in a modern sense did not begin until the last quarter of the nineteenth century. It was then concentrated primarily in Central Russia, where manufacturing of consumers goods predominated, in the Baltic states and Poland, and in the Ukraine, where the abundance of Coa land Iron ore and a developed transportation net provided unusually strong incentives for industrial development.

Problem of over population in Asia

Some countries of Asia are overpopulated. Infact there is no country which is over populated or underpopulated. It is national income that determines these relative terms. If the national income is greater and sufficient to feed the people of the country can never be called a overpopulated even that there may be 600 million people. But if the income is not sufficient to feed the countrymen even England. Japan and any other small island only for example, may be called overpopulated.

So far as Asia is concerned the overpopulation problem is nor a new but for centuries back. And the overpopulation can be accounted due to three facts : Firstly, the insufficient national income due to unexploitation of natural resources ;

Secondly, the agrigarian structure of population ;

Thirdly, the immobility of the people.

- Immobility of labour is due to two facts :
  1. Love for their native land and kith and kins,
  2. Lack of Territories.

Japanese attack on north China only to solve the problem of population but badly failed to get success. The overpopulation created many changes. It brings economic changes. When the people begin to starve they revolt against government and thus economic changes become the reason for political changes. Chiang Kai Shek was thrownout from the mainland of China only due to the economic crisis. Manchuria is still sparsely populated and has been a bone of contention among the nations for centuries.

Thus the overpopulation of Asia also results many crises. And the solutions are to settle in the underpopulated area if (political ideologies permit) and development of industries, to explore the natural resources and as well as to develop the trade. Then and then only the population problem can be solved. There is also urgent need to check the growing population by family planning or some other preventive measures or used mechanical devices.

South east Asia is the store of all sorts of natural resources. But no one had dare to utilize these resources. There had been lack of education, technicians and experts. This part of Asia called for labours.

China a sleeping lion according to Napolean, now awakned and they utilized vast natural resources of their country. The population problem as such was not a major point of discussion either by communist officials or by the country's press until 1954, when the results of the 1953 census registration were published. With the disclosure that the population of Mainland China was almost 600 million and with the release of sample vital rates which indicated a population growth of some 12 to 13 million annually, the demographic problem became a major concern.

Can China feed and generally take care of the millions? China's food production, taking into account some severe setbacks, grew faster than its population. China imports wheat but it also exports rice; the imports, moreover, have not increased over the last decade. Perhaps for these reasons and because of changing political attitudes, the theory of expansion-for-living-space is no longer "in" as for as with the standard of western countries are concerned.

Even when the theory was in fashion, the Chinese had embarked on a vigorous programme of family planning. The programme has had its ups and downs but it has been in operation for the greater part of the last 20 years. But the early 1960s, China appears to have succeeded in lowering its birth rate to about 2·5 percent. It also overlooked the fact that the countries around China's periphery are just as thickly populated as China proper. Moreover, almost two-thirds of China which lies outside the Great wall is virtually empty. This region is admittedly difficult

to open up for cultivation but no more so than, say, Soviet Siberia which the Chinese were supposed to covet for expansion.

The original Chinese target was to reduce population growth to one per cent by 1970. That target has obviously not been achieved. At present, for the country as a whole, the growth rate may have come down about 2 percent. The current policy of energetically promoting late marriages, providing free contraceptives and facilities for abortion and sterilisation has, it is claimed already succeeded in urban areas. Peking is said to have brought down its growth rate to 1·24 percent: Shanghai has done even better with a record of only 0·69 percent. In rural areas, however, progress has been and will be slow but the trend towards decline in population growth is clear.

Of the three great nations of Asia, China has chosen the road of communism and a centrally planned and controlled economy ; India has undertaken planned development in a mixed economy ; but Japan has chosen to build its future on a private enterprise system. Japan cannot feed itself, the cultivated area cannot be substantially increased ; and the average farmer cannot live by farming alone. There is an estimated surplus far population of three to six million and a surplus of 1·3 million commercial and service workers. New entrants to the labour force, seeking employment for the first time, number 800,000 to 900,000 each year. Further industrialization is the hope for expanding the economy to absorb this surplus population, but raw-material resources are inadequate for the necessary expansion of industry. The two major factors that will determine Japan's ability to achieve full employment are capital investment are the export trade of the two, the increase of exports is the more difficult.

POPULATION DISTRIBUTION IN EUROPE

According to Blache the European agglomeration of population begins where the Asian agglomeration ceases It seems that more than two-thirds of the population of Europe forms a compact block of almost uniform high density. Fig 19·3, shows the population of Europe.

The pattern of population distribution in Europe is mainly influenced by the ecological as well as cultural developments of that continent. There are human agglomerations in the river deltas but the agricultural population is not so dense as in India or China. Large human concentrations are to be found in industrial areas. The importance of coastal location for foreign trade is very remarkable.

The chief ecological factors controlling the distribution of population in Europe at present are climate, the relief and fertility of the land, and the distribution of mineral wealth, especially that of coal. But the cycle of population in any mineralized area is just as humanity increases in numbers by swarming, after the

manner of bees, rather than by adhering in clumps like corals...... ......when the hive is too full, a swarm leaves it."[1] Such is

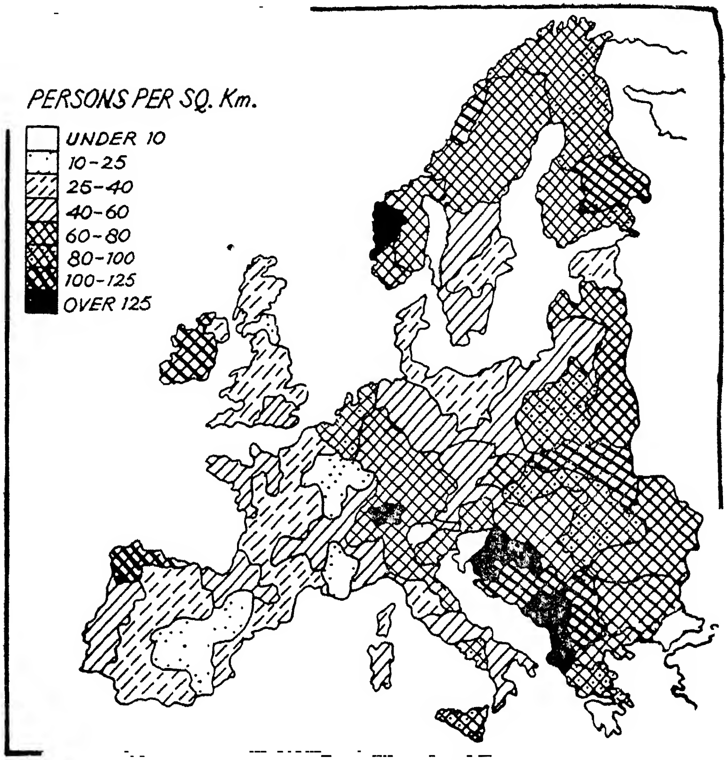


Fig 19 3. Population density of Europe.

the history of population in mineralized parts of the earth of all time.

On the mainland of Europe, the coastal countries of English Channel and North sea the density of population is high, which signifies the all round industrial progress of Europe. Here are found great Urban centres of France, Belgium and Germany ; the valley of Rhine is also within these industrial Urban connections. The density of population in the coal fields areas of France and Germany is very high. According to Taylor, "The dense population in Europe is distributed along the coal belt from Swansea to Silesia. Here temperature is obviously not the main factor. Another obvious control (tending to prevent settlement) is elevation though here temperature is connected as well as absence of good soils and difficulty of communications. Hence, we shall find that the temperature effect is least complicated by other factors in the

1. Blache, op. cit., pp. 68 and 70, 1959.

lowland regions where no coal is present."[1] Belgium has long been plagued by the linguistic and cultural division between the Flemish-speaking population in the north and east and the French-speaking walloons in the South. Until recently, economic and political control of the country has remained with the Wallons but the present increase of Flemish population seriously challenges this domination. A further threat has developed through the growing migration of industry from the South into the Flemish-speaking area. The gradual exhaustion of coal deposits in the Sambre-Meuse valley coupled with the discovery of important new seams in the Kempenland has given impetus to this migration. Large tracts of hitherto useless land have been reforested, and other areas, through the use of fertilizers and irrigation have been transformed into productive farm lands. Land reclamation is still going on in this crowded country, where the population density today exceeds 400 persons to a square kilometre.

Another population concentration is to be found east of the Rhine valley along eastern Germany, and according to Taylor, "In Europe the largest areas of heavy population occur in the Rhine and Po valleys below 180 m. and along the slopes of the Bohemian Highland, etc., at about 450 m. only." In Spain and Bulgaria are there many inhabitants above 900 m. Holland, one of the most densely populated countries of Europe, has begun reclaiming land from the Zuider Zee. Poland has been one of the outstanding example in Eastern Europe of an agrarian economy unable to provide employment for many persons whose livelihood depends on agriculture.

The Balkan peninsula is today one of the critical areas of the world. As a direct result of world war II, there have been major changes in the political conditions, social and economic structure, boundaries, and territorial demands. This is especially true of Yugoslavia, on which world attention has been foccused for some time. In 1946, Yugoslavia was reorganized into the Federal People's Republic of Yugoslavia. Postwar additions from Italy of Istria, Zara, the Cherso-Lussino island group, and the island of Lagosta increased the areas of Yugoslavia from 249,468 square kilometres to 256,850 square kilometres. The population rose from 13,934,038 (1931) to 15,751,935 though there was an estimated direct loss of 1700,000 in world war II, comparatively one of the higher losses among the nations.

In Mediterranean Europe there is no extensive belt of human concentration like central Europe. It is due to the fact that the Mediterranean Europe is mostly mountainous. In Mediterranian countries, a great variety of crops are grown such as vines, fruits, early vegetables, tobacco, maize etc. Here the garden rather than the field was the focus of sedentary life. In the drier district of

1. Taylor, Enviornment Race and Migration, p 433.

France, olives are grown. Here the main bases of population are agriculture and dairying.

In France the most thinly settled departments are Basses—Alps with 40 to the sq. km. and Hautes-Alps with 50, which again owe even these figures in part to their situation on the margin of the densely populated valley of the middle Rhone. "Manpower shortages already faced France before world war II, when almost 200,000 foreigners were being imported in some years. The same situation has now also become serious for other European countries like Britain, Belgium, Sweden, and west Germany (400,000 imported in 1900). All of these countries have less than .0 percent of their population below the age of 15 years."[1]

Norway, almost wholly a mountain country, average only 11 persons per sq km. Less than a thousand sq. km. of its territory are under cultivation and these are distributed in small deltas at the heads of the fiords, in low strips here and there along its western coasts, or in the openings of its mountain valleys to the Southeast. Here too is massed the larger part of its inhabitants. A barren granitic soil, unfavourable zonal location, excessive rainfall, paucity of level land, leaving the "upright farms" predominant, and remoteness from any thickly settled areas, together with the resulting enormous emigration, have combined to keep down Norway's population.

Finland, for the most part, is sparsely populated. It occupies a forested area where the chief means of livelihood is lumbering and the most important motive power is horses. Hay is needed for these horses and milk and fresh meat should be produced for the increasing village and forest population, many of whom are undernourished. There is little hope of growing grain economically so far north, but hay and dairy farming offers a real hope for raising the living standards. About 70% of the land to be cleared is tillable, and its nitrate content is uniformly high. The hay fields are to be made large and free from obstructions so that farm machinery can be used everywhere.

In Europe the density of population depends on commerce,, industries, trade and communication and mineral exploitation where as in Asia the concentration of population is based on agriculture.

In Great Britain, the sparsest population is found in the sterile highland moors of Scotland, where the country of Southern upland has only 9 inhabitants to the square km. These figures reveal also the remoteness of a far northern location. In the Southern half of the island the sparsest populations are found in the Wales county of Radnor, Montgomery etc. with 30 to the sq. km. and in English westmoreland with 60, both of these mountain regions, but reflecting in their larger figures their close proximity

1. Howard F. Gregor, Environment and Economic life, pp. 262-363, 1963, New York.

to the teeming industrial centres of South wales and Lancashire respectively.

The production of food differs in various parts of Britain according to the soil, climate and other ecological conditions. The population of Britain had become accustomed to a much higher standard of living, particularly to more meat and dairy products, which require more land for their production. Britain can supply only about half the population's food needs from its own farm land, it is important to get the best out of every hectare that is worth cultivating. The regions of densest population on the mainland of Europe are :

1. an area embracing the fertile basins of the Rhine, Somme, Scheldt, and lower Seine, and possessing several coalfields ;

2. an area stretching over much of central Germany, and extending South-eastwards into Czechoslovakia and Poland, which is also rich in mineral;

3. the northern portion of Italy or Po valley, which is extremely fertile;

4. industrial attractions explain similarly high densities in Northwestern Europe.

The least populated regions are :

1. The northern portion of the continent, where the climate is cold and the soil relatively unproductive,

2. South-eastern portion of Eurasia, which suffers from drought, and has a salt and sandy soil,

3. Alpineland and the central plateau of Spain, where agriculture is impossible over large areas.

The whole of European Soviet Russia, as well as White Russia, the Ukraine, the Baltic states and the Balkan peninsula have but a slight population compared with the countries of Central Europe.

POPULATION OF NORTH AMERICA

In North America about 85% of the people are living east of 100° W. longitude. The reason is that America was settled mostly by European immigrants and they could penetrate the continent from the east. Hence human settlements firstly took place in the eastern Atlantic Seaboard. As the human pressure went on increasing these eastern human concentrations not only became dense but also spread westward and northward. In the west the density of population is higher only in particular areas where the irrigational facilities and mineral resources are available for human attraction.

Physiographically, Canada is a large country stretching from the Atlantic Ocean to the Pacific and from the United States to the Arctic, covering an area of 10014703 km.^{2} But it has a small population of 21,000,000.

Canada is a land of high mountains, vast forests (some of the world's largest), huge lakes, Salmon-filled rivers, kilometres of wheat lands and great mineral wealth, modern industries and breath-taking scenery.

Consisting of extensive level plateau covering the area between the St. Lawrence river in the East and the Great Plains in the west and the Great Lakes in the South. The area gradually slopes toward the Arctic ocean and extends all round the Hudson Bay—called the Canadian or Laurention Shield. It is one of the oldest parts of the earth's surface. Completely covered by layers of ice during the winter which melted and receded flooding the Hudson Bay and leaving a string of lakes. The largest is the Great Bear lake and Great Slave Lake where Eskimos and Indians still live by hunting and fishing.

The rocks here have vast mineral wealth and this area has gold, silver, and world's largest resources of uranium, nickel and asbestos. Timber is an important product from the Canadian forests—amongst the world's largest. The timber is used for producing newsprint and other types of paper.

The original inhabitants of Canada were the Eskimos and American Indians who now form a fraction of the population which is mostly European (British) and French. There is also a sizable Indian community (mainly Sikh).

Population is densest in the food production area, and particularly in the interior continental plain including prairies. The densest population in Canada are distributed along the food production belts. They are :

1. The Pacific coastal area of British Columbia and river valleys;
2. Agricultural zone of prairies provinces, and
3. Ontario peninsula and the St. Lawrence valley the Eastern region drained by the St. Lawrence river as this is the industrial area where most of the people live.

Population is naturally exceedingly sparse in the cold regions of the far north, and in the marshy and moorland of Central Canada, as well as in those of North-West territories. It is fairly dense, and capable of considerable increase, around the sea-board of the Atlantic, in the Great lakes, and Western Pacific Coast. Fig. 19 4 shows the density of population in North America.

The United States has very much of a balanced economy which supports dense population. Over the whole of the United States of America the population per sq. km. averages 30, the mean density in the outlying territories being 400 and in the states 31. If we take the states as a unit and exclude cities, the mean density ranges between a minimum of 5 and a maximum of 160 per sq. km. There is a great variation in population density in the U.S.A. The Eastern half of the United States is more densely

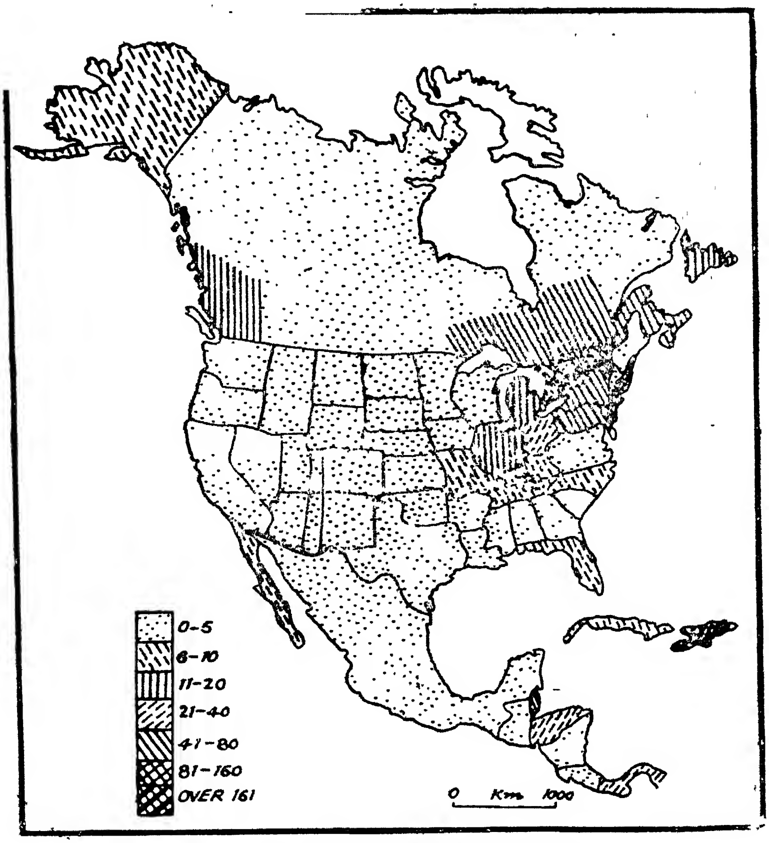


Fig. 19·4. Population density (persons per km).

populated than the western. In the eastern half of the United States, the densely populated areas are good argricutural regions such as the Mississippi valley, or those where commerce or industry or both, are highly developed. Areas with sparse populations in this part of the tract include the rough country such as parts of the Appalachians and poorly drained areas. The dense populations of the western half of the United States are in the valley of California and adjacent areas, the Willamette valley of Oregon, and the Puget Sound region of Washington. By contrast with these four states, Montana (4), Idaho (8), Wyoming (3), and Nevada (2), are sparsely inhabited. In these areas the land is too unproductive to support a flourishing agricultural population.

In the continent of North America, Mexico is the only area that is least developed in spite of its varied potentialities and population is dense. The West Indies and Central America form the Tropical dependencies of the United States and Canada.

Distribution of Population in the three Southern Continents

It is said that once upon a time there existed a big old continent known as the Gondwana land which, later, was broken into the present-day three southern continents of South America, Africa and Australia. The three southern continents are economically backward, owing to backward and lack of communications. The southern continents are new continents with reference to the economic development and population problems. In the three southern continents the-present day movements of population are from thinly peopled areas towards densely people areas rather than the reverse.

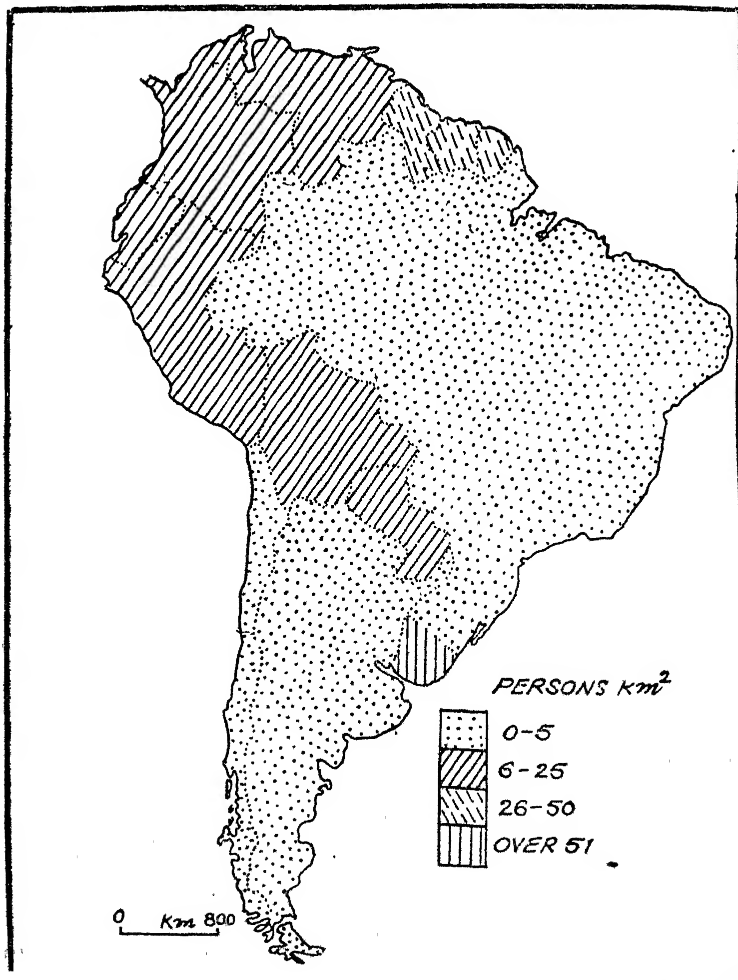


Fig. 19·5. Density of Population in S. America.

The variation in population density which is so apparent for the world as a whole, is similarly marked in South American countries. The present pattern of population distribution in the South American countries represents an evolution from that of the colonial period, when white inhabitants were few in number and settlement was confined largely to the Atlantic seaboard. This settlement of the interior and of the west coast has been accompanied by a westward shift of the centre of population. In the middle latitudes the density of population is due to the agricultural facilities such as are found in the plains of Argentina, Uruguay, Paraguay etc. On the contrary for British Guina with about 2 persons per square km. its inhabitants concentrated on the low-lying coast lands and its interior largely deviod of people, remains very sparsely populated. Fig 19·5 shows the density of Population in S. America.

British Guiana, for the most part, is sparsely populated. Some 94% of the 377,000 inhabitants occupy only 4% of the area —the coastal strip. The remainder are scattered over the mountains forests and Savannas that cover the rest of the country. Sugarcane is the main crop and has been the chief source of revenue since 1660s. Although there is little chance of further expansion because of the rationalization of the industry, present methods of production could be made more efficient. Rice is grown widely but for the most part is consumed locally. An expansion scheme is being attempted that would be needed to feed a larger population and for export to the West Indies Among the mineral products are bauxite, second to sugar as on export, gold and diamonds. Forests cover some 12000 sq. kms and yield many types of timber of commercial value. Balata gum, used for insulation, and Coconut products are also obtainable. Improvement of dairy and beef stocks could help the food supply, along with pork, poultry and citrus fruits.

A large population of the inhabitants find a livelihood in the grazing of cattle and the exploitation of the extensive forests. The greater part of west of South America consists of mountains and broken country where cultivation of an inferior kind is possible only in the narrow valleys and on the more gentle slopes. It consists the hilly countries of Peru, Ecuador, Colombia, etc. One of its countries, Bolivia is the most sparsely populated. Venezula and Surinam in the north have also a very scanty population.

The greater part of Brazil is covered with forest and high hills. Although 71 percent of the population are agriculturists, they earn only 30% of the nation's total personal incomes, whereas 5% of the population receive 50% of the total. Brazil is a underpopulated country with promising frontier. The real Brazil is only to be found in the back country, in the thinly populated wildness beyond the frontiers of concentrated settlement called the "Sertoa". Although the population density is only about one-third that of the United States. Throughout the remaining countries the condi-

tions are fairly homogeneous, and the variations in the density are not very great.

Population of Africa

Although the continent occupies a fifth of the land area of the globe, it has only 7·5% of the population, 3 percent of the agricultural production, 9% of the metals, 5% of the rail-roads and 5% of the trade of the world.

The population distribution in Africa, is too marginal. Here density of population is found along the Mediterranean coast the Nile Delta, in the Southern coastal regions, and Southern Rhodesia. The total population of Africa at present is not known. This is because accurate enumerations are lacking for many areas.

The population of Ghana in 1960 was 6,726,815; in 1971 it was 9000,000. Between the two censuses there was a net gain of 74·7% in population. This increase would have been made up of fertility rate, mortality rate and migration rate. But the rate of increase was not the same for all parts.

Western Africa includes Upper Volta, Togo, Sierra Leone, Senegal, Nigeria, Niger, Mali, Liberia, Ivory coast, Guinea, Ghana, Gambia and Dahomey etc. These countries from a distinct geographical unit, although in detail their geography must differ, they are in varying degree by distance from the Atlantic climatic influences. All these areas have high rural population densities to the square km. Ghana, Gambia, Nigeria have each more than 60 persons to per sq. km. These areas are depressed rural areas.

North Africa is regarded as the transitional climatic region between the Mediterranean north and the hot continental south, it contains the countries of the UAR. Tunisia, Sudan, Morocco. Libya and Algeria. The three—Morocco, Algeria and Tunisia—lie mainly among the Alpine mountain folds of Atlas; the other occupy a large part of the Great Nile plain, Libyan desert and the massifs of the central uplands with their intervening basins. Morocco was estimated to have a total population of 16·3 million in 1971, thus ranking third in the Arab world after the UAR and the Sudan, and seventh in Africa.[1] Algeria is a country of marked physiographic contrasts, which set definite limits to its agriculturally productive potentialities. Where the conditions are naturally suitable for agriculture the soil is excellent. But considerable areas of the country are either desert or too arid for successful agriculture without being actual deserts in the usual sense of the term or salt marshes. The total population at the 1971 census was 14,000,000. Less extensive areas of high population density are found around coastal cities and small coastal plains. According to K. Sutton, "Generally the coastal strip has above 50 inhabitants per sq. km. ranging up to a peak of just above 40,000 per sq. km. in the first

1. Clarke and Fisher, Populations of the Middle East and North Africa, op. cit. Morocco : urbanization and concentration of population by G. H. Blake, p. 404, 1972.

and second arrondissements of the city of Algiers......More continuous extends of high density settlement are found in the Mitidja plain and Sahel behind Algiers.........Generally the communes of the high plains, steppes and Saharan Atlas show sparse population densities.........Relative density as a population parameter loses its meaning in the Sahara departments, where high density oases contrast with almost total absence of population in vast areas, and seasonal nomadism adds a further difficulty to the study of distribution."[1] The total geographical area of Egypt is 1,002,000 sq. km. with a population of 34·9 million (1971) and population density 33·9 persons per sq. km. The major portion of population resides in the villages and their economic prosperity depends largely upon the growth and development of agriculture. Density of population per habitable square kilometre has much more significance and according to Mountjoy it was as high as 843 in 1967.

The South African rural population is located mainly in an arc that stretches from a point south of Bulawayo eastward through Shabani and Fort Victoria to Umtali and Salisbury. The higher densities in the native areas are in marked contrast with the neighbouring European farmlands. The arc is much wider to the north, in the upper Sabi valley, where rainfall is more reliable and more plentiful. West of the Bulaways-Salisbury axis the much smaller African population is more widely distributed, though there are local concentrations at Dagamella, west of Que-Que, and in the Sipolilo Native Reserve, north west of Salisbury.

Sahara is the largest desert area of the world. Here the population is found only on the oasis where water is available. Fig. 19·6 shows the distribution of population in Africa.

Central and Middle Africa is a region of mediocre fertility, without navigable waterways, large forests and even over immense stretches; a region broken up by deep ravines which, according to the season, are torrents of water or beaches of dry gravel making it very difficult to establish good means of communication. On his rough, uneven soil the farmer has to fight not only against the difficulties that he meets in other climates but also against disastrous plagues which only too often come to destroy the fruits of the hardest toil and demolish the fairest hopes—factors like the irregularity of the climatic phenomena, exceptional dryness, torrential rains, in certain regions floods, grasshoppers, flies, epidemics and epizootics. Heavy concentrations of population are found in coastal areas, particular y in the drier, western parts of the main islands of Pemba and Zanzibar. Here fragmentation of holdings, severe erosion, and declining crop yields, together with the non-availability of unused land of even moderate quality, all

1 K. Sutton, Al e-ia : changes in Population distribution pp. 378–379, Edited by J. I. Clarke and W B. Fisher, 1972.

point to a situation in which continued population growth must give cause for grave concern.

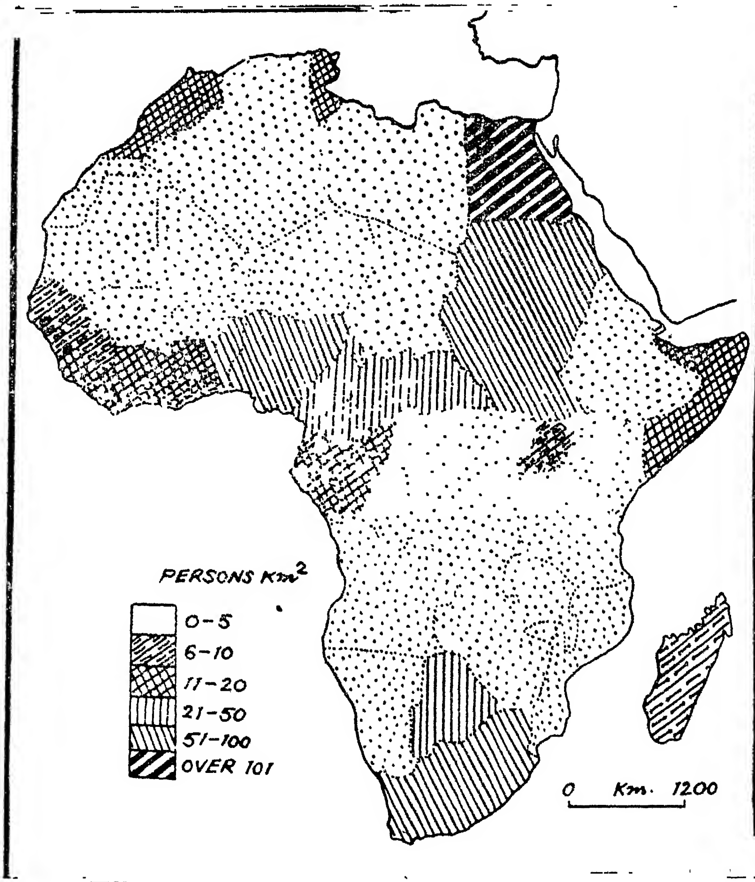


Fig 19·6. Density of Population in Africa

Population Distribution in Australia

Geographically, Australia is an Indo-Pacific continent but demographically it is European. The discovery of Australia was delayed for a vary long time because of its almost directly antipodal position to Spain, the great exploring nation of those times. The bulk of the present population of Australia consists of settlers from Europe and their descendants ; but Chinese are found in some parts, notably Queensland, though their entrance is now rendered very difficult by various restrictions. The average annual rainfall over two-thirds of Australia's total area of 7 million square kilometre is less than 50 cms. Much of the Interior and western Australia is too dry for agricultural land and the humid

tropical climate of the northern part has likewise been a deterrent to settlement, as shown in fig 19·7.

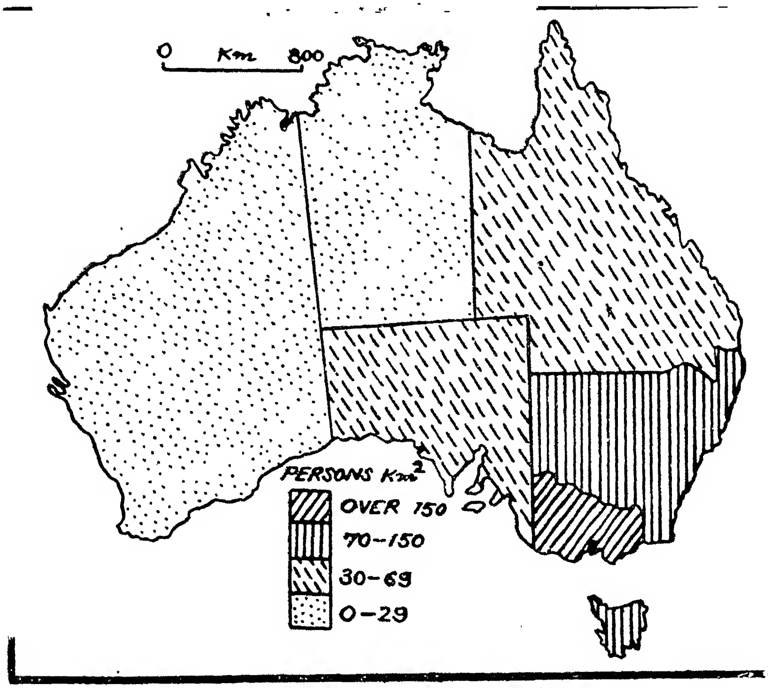


Fig. 19·7. Population Distribution in Australia.

The Northern territory, almost wholly a mountainous country and densily is only 7 persons to the sq. km. Territories that have much agricultural land, but which have some industrial areas or are near large population centres, have a density varying from 600 to 1500 persons per sq. km. Included in this group are such territories as Tasmania, New South Wales and Victoria. The territories mainly dependent on agriculture only have under 300 persons per sq. km. An overwhelming proportion of Australian's population is today concentrated in the "crescent" of economic Australia.

The continent of Australia has large uninhabited areas. In reality the population pattern in all the newly settled continents is everywhere same, because the coastal areas were the most suitable for the immigrants to settle. Later on with the increase in population, the inner areas were also gradually settled. Australia provi des a good example of this fact.

The temperate climate and the fertile soil, coupled with freedom from drought, make New Zealand an ideal pastoral country with considerable population density. Appendix A shows the population data of the world.

APPENDIX A :

World Population Data

Region/ country	Population 1971 (millions)	Annual births per 1000 population	Annual deaths per 1000 population	%Annual rate of growth
Africa	**354**	**47**	**20**	**2·7**
Algeria	14·5	50	17	3·3
Libya	1·9	46	16	3·1
Morocco	16·3	50	15	3·3
Sudan	16·3	49	18	3 2
Tunisia	5·2	45	14	3·1
UAR	34·9	44	15	2·8
Dahomey	2·8	51	26	2·6
Gambia	0·4	42	23	1·9
Ghana	9·3	48	18	3·0
Guinea	4·0	47	25	2·3
Ivory coast	4·4	46	23	2·4
Liberia	1·2	41	23	1·9
Mali	5·2	50	25	2·4
Mauritania	1·2	45	23	2·2
Niger	4·0	52	23	2·9
Nigeria	56·5	46	25	2·6
Senegal	4·0	45	22	2·4
Sierra Leone	2·7	45	22	2.3
Togo	1·9	51	24	2·6
Upper Volta	5·5	49	28	2·1
Burundi	3·7	48	25	2·3
Ethiopia	25·6	46	25	2·1
Kenya	11·2	50	20	3·1
Malagasy Rep.	7·1	46	22	2·7
Malawi	4·6	49	25	2·5
Mauritius	0·9	27	8	1·9
Mozambique	7·9	43	23	2·1
Reunion	0·5	37	9	3·1
Rewanda	3·7	52	23	2·9
Somalia	2·9	46	24	2·4
South Rhodesia	5·2	48	14	3·4
United Rep. of Tanzania	13·6	47	22	2·6

Uganda	8·8	43	18	2·6
Zambia	4·4	50	20	3·0
Rep. of Angola	5 8	50	30	2·1
Cameroon	5·9	43	21	2·2
Cen. African Rep.	1·6	48	26	2·2
Chad	3·8	48	23	2·4
Dem. Rep. Congo	17·8	44	21	2·3
Rep. of Congo	1·0	44	23	2·3
Gabon	0·5	35	26	0·9
Sw. ziland	0·4	52	22	3·0
South Africa	20·6	40	16	2·4
Asia	**2104**	**38**	**15**	**2·3**
Cyprus	0·6	23	8	0·9
Iraq	10·0	49	15	3·4
Israel	3·0	26	7	2·4
Jordan	2·4	48	16	3·3
Kuwait	0·8	43	7	8·2
Lebanon	2·9	—	—	3·0
Muscat and Oman	0·7	42	11	3·1
Saudi Arabia	8·0	50	23	2·8
S. Yemen	1·3	—	—	2·8
Syria	6·4	47	15	3·3
Turkey	36·5	43	16	2·7
Arab Republic	5·9	50	23	2·8
Afghanistan	17·4	50	26	2·5
Bhutan	0·9	—	—	2·2
Ceylon	12·9	32	8	2·4
Iran	29·2	48	18	3·0
Nepal	11·5	45	23	2·2
Pakistan	141·6	50	18	3·3
India	585·0	42	17	2·6
Bangla Desh	50·0	25	20	2·1
Burma	28·4	40	17	2·3
Combodia	7·3	45	16	3·0
Indonesia	124·9	47	19	2·9
Laos	3·1	42	17	2·5
Malasia	11·1	37	8	2·8
Philippines	39·4	46	12	3·4
Singapore	2·2	25	5	3·3
Thailand	37·4	42	10	2·1

Vietnam	39·9	—	—	—
Rep. of China	772·9	33	15	1·8
Taiwan	14·3	26	5	2·3
Hongkong	4·3	21	5	2·5
Japan	104·7	18	7	2·8
Korea	57·2	37	11	2·7
Mongolia	1·3	42	10	3·1
Europe	**466**	**18**	**10**	**0·8**
U.K.	56·3	16·6	11·9	0·5
Sweden	8·1	13·5	10·4	0·5
Norway	3·9	17·6	9·9	0·9
Ireland	3·0	21·5	11·5	0·7
Iceland	0·2	20·7	7·2	1·2
Finland	4·7	14·5	9·8	0·4
Denmark	5·0	14·6	9·8	0·5
Austria	7·5	16·5	13·4	0·4
Belgium	9·7	14·6	12·4	0·4
Fed. Rep. Germany	58·9	15·0	12·0	0·4
Luxembourg	0·4	13·5	12·6	1·0
Netherlands	13·1	19·2	8·4	1·1
Switzerland	6·4	16·5	9·3	1·1
France	51·5	16·7	11·3	0·7
Bulgaria	8·6	17·0	9·5	0·7
Czechoslovakia	14·8	15·5	11·2	0·5
Dem. Rep. of Germany	16·2	14·0	14·3	0·1
Hungary	10·3	15 0	11·3	0·4
Poland	33·3	16 3	8·1	0·9
Romania	20·6	23·3	10·1	1·3
Albania	2·2	35·6	8·0	2·7
Greece	9·0	17·4	8·2	0·8
Italy	54·1	17·6	10·1	0·8
Malta	0·3	15·8	9·4	—0·8
Portugal	9·3	19·8	10·6	0·7
Spain	33·6	20·2	9·2	1·0
Yugoslavia	20·6	18·8	9·2	1·0
U.S.S.R.	245	17·0	8·1	1·0
North America	**229**	**18**	**9**	**1·2**
Canada	21·8	17·6	7·3	1·7
United States	207·1	18·2	9·3	1·1

Central and South America	**291**	**38**	**9**	**2·9**
Costa Rica	1·9	45	8	3·8
El. Salvador	3·6	47	13	3·4
Guatemala	5·3	42	13	2·9
Honduras	2·8	49	16	3 4
Mexico	52·5	42	9	3·4
Panama	1·5	41	8	3·3
Caribbean	26	34	10	2·2
Bolivia	4.8	44	19	2·4
Brazil	95·7	38	10	2·8
Colombia	22·1	44	11	3·4
Ecuador	6·3	45	11	3·4
Guyana	0·8	37	8	2·9
Peru	14·0	43	11	3·1
Surinam	0·4	41	7	3·2
Venezuela	11·1	41	8	3·4
Argentina	24.7	22	9	1·5
Chile	10·0	34	11	2·3
Paraguay	2·5	45	11	3·4
Uruguay	2·9	21	9	1·2
Oceania	20	25	10	2·0
Australia	**12·8**	**20·0**	**9·1**	**1·9**
New Zealand	2·9	22·5	8·7	1·7
Fiji	0·5	29	5	2·7

CHAPTER 20

POPULATION CAPACITY OF THE EARTH

The carrying capacity of the earth is based on two factors—

First is the volume of resources in the world as a whole in relation to the size and growth of population,

Second is the relation between the distribution of population and the distribution of means of livelihood among the various regions of the world.

SIZE OF WORLD POPULATION IN RELATION TO RESOURCES

Is the earth big enough to support the extra people ? Will there be enough food ? Enough fuels ? Enough metals ?

If the present rapid increase in population should continue unchecked, the number of people in the world would become so large that it would be impossible to feed them all and many would die of hunger. The most optimistic say that it would be possible to feed about 10 times the existing population. At the present rate of increase we shall reach that point in about 150 years. Others, more pessimistic, point out that already 2,100 million people—three quarters of the human race-do not get enough to eat.

Thus food production is one of the most important of the world's problems for the future. Table 20·1 shows the future demand of food supplies.

Table 20 1

Percentage of food requirements per capita for developing countries, 1965—1980 and 1965—2000*

Region	1965—1980		1965—2000	
	Total	Per capita	Total	Per capita
Total Developing Region	75	24	226	53
Far Fast	79	29	244	72
Middle East	75	17	181	17
Africa	66	14	220	28
Latin America	17	12	185	12
Total yearly rate of increase in percentage				
Total Developing Region	3·8	1·4	3·4	1·2
Far East	4 0	1·7	3·6	1·6
Middle East	3·8	1·0	3·0	0·4
Africa	3·4	0·9	3·4	0·7
Latin America	3·6	0·7	3·0	0·3

* Sen, Impact of Population growth on food supplies, 1967.

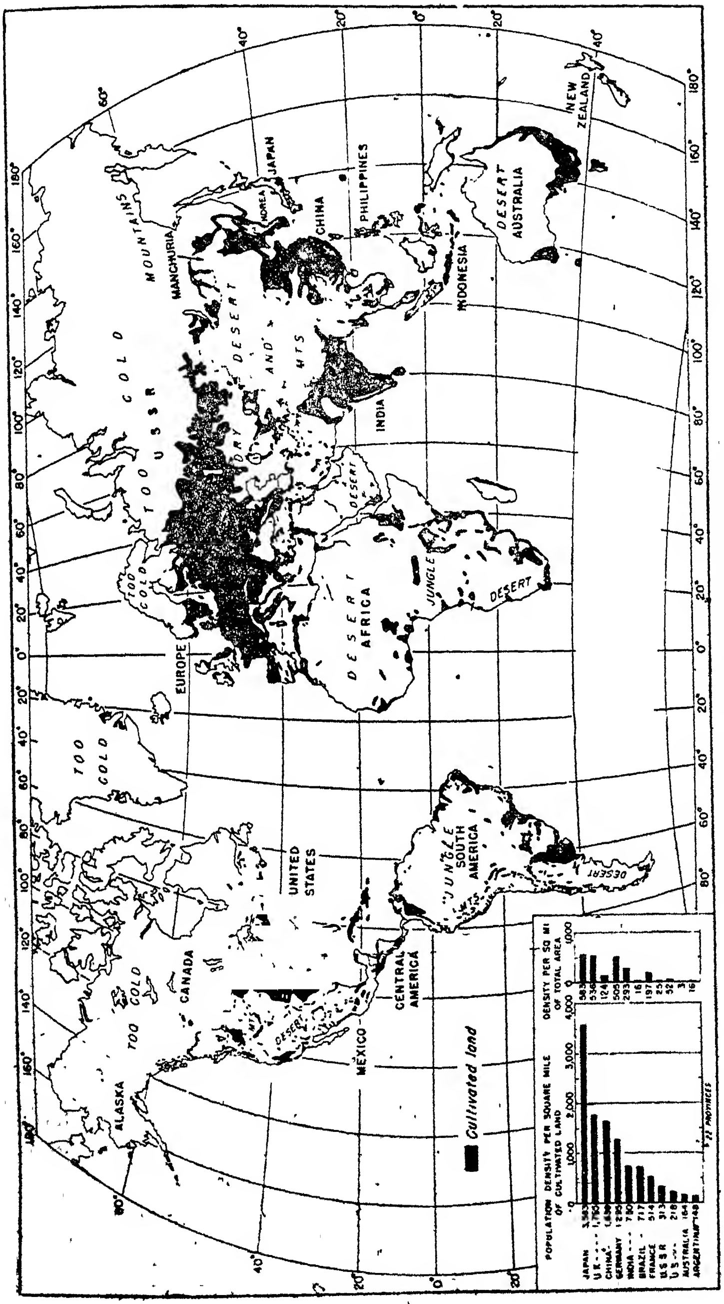


Fig. 20·1. Possible cultivated land areas.

Amount of Land under Cultivation

The story of man's use and misuse of land goes back to prehistory. In the ancient society only the gathering of wild fruits and hunting of animals were the main occupations. Social life in the old stone age seems to have moved from one source of raw material to another. In the last stage man discovered that he could collect seeds and grow them, and raise a crop.

The original homes of wheat, barley, rice and rye and other crops have now been located in different portions of the globe which are associated with original human settlers. Large groups settled in river valleys in agricultural colonies. In the primary Era of human civilization agriculture remained undeveloped. This was due to the fact that only the fertile land was cultivated and the comparatively smaller fertile land was left uncultivated In this way the balance of nature prevailed. That was the time of largest voids and small populations. But now the condition has become opposite.

The net cultivated land of the whole world during 1960–61 was 1384 million hectares; that is 10·1% of the total reporting geographical areas, which is shown in fig. 20 1. 30 9 percent of the total cropped area of the whole world is in Asia. The second highest percentage of agricultural area of the world is in North and Central America about 18·9% followed by Africa 16·6%, the U.S.S.R. 15 6%; Europe 10·0%; South America 5·0% and Oceania 3%. Fig. 20·2 shows the distribution of most product lands The distribution of cultivated and potentially arable land in relation to population and area of continents is shown in table 20·2.

Table 20·2

Present population and cultivated land compared with potentially arable land of each continent.[1]

	Population in 1971 (millions)	Area in billions of hectares			Hectares of cultivated land per person	Ratio of cultivated to potentially arable land (percent)
		Total	Potentially arable	Cultivated land		
Africa	354	2 984	0·724	0·156	0·52	22
Asia	2104	2·704	0 620	0·512	0·28	83
Oceania	20	0·812	0·152	0·016	1·16	2
Europe	466	0·472	0·172	0·152	0 36	88
N. America	229	2·084	0·460	0·236	0 92	51
S. America	291	1·732	0·672	0 076	0·40	11
U.S.S.R.	245	2·208	0·352	0·224	0·96	64
Total	3706	12·996	3·152	1·372	4·60	64

1. The World Food Problem, 1967, F.A.O.

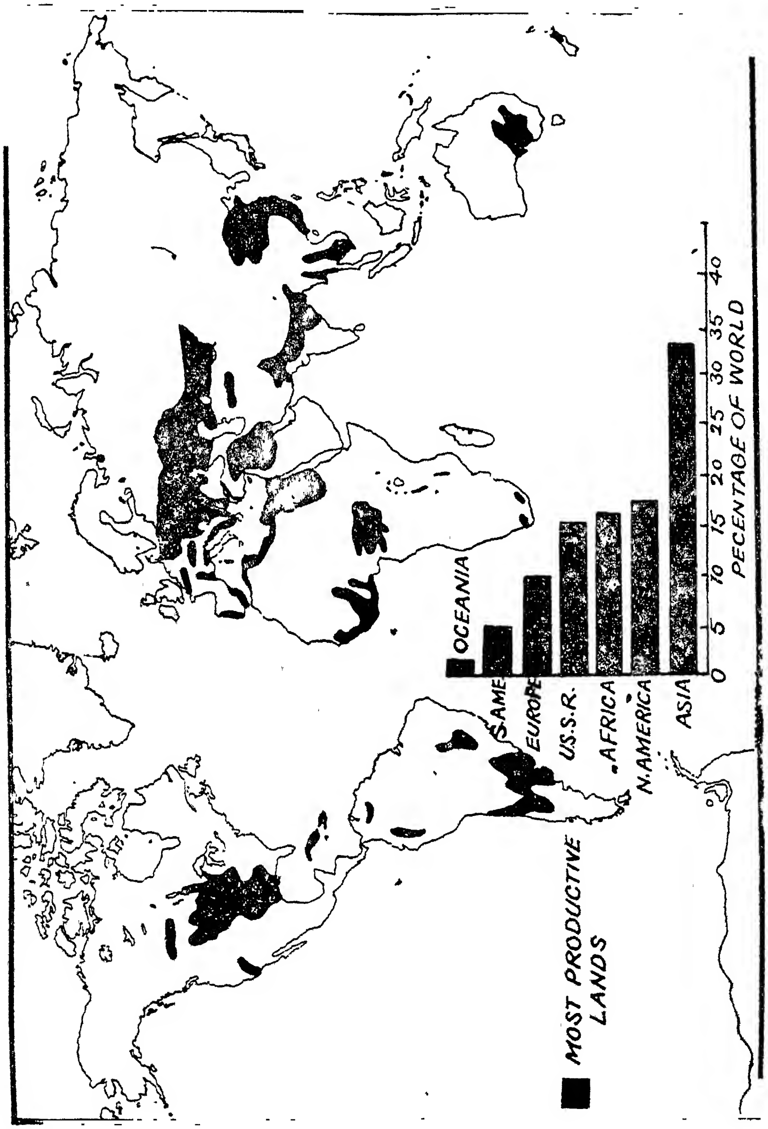


Fig. 20 2. Most Productive Land Areas of the World.

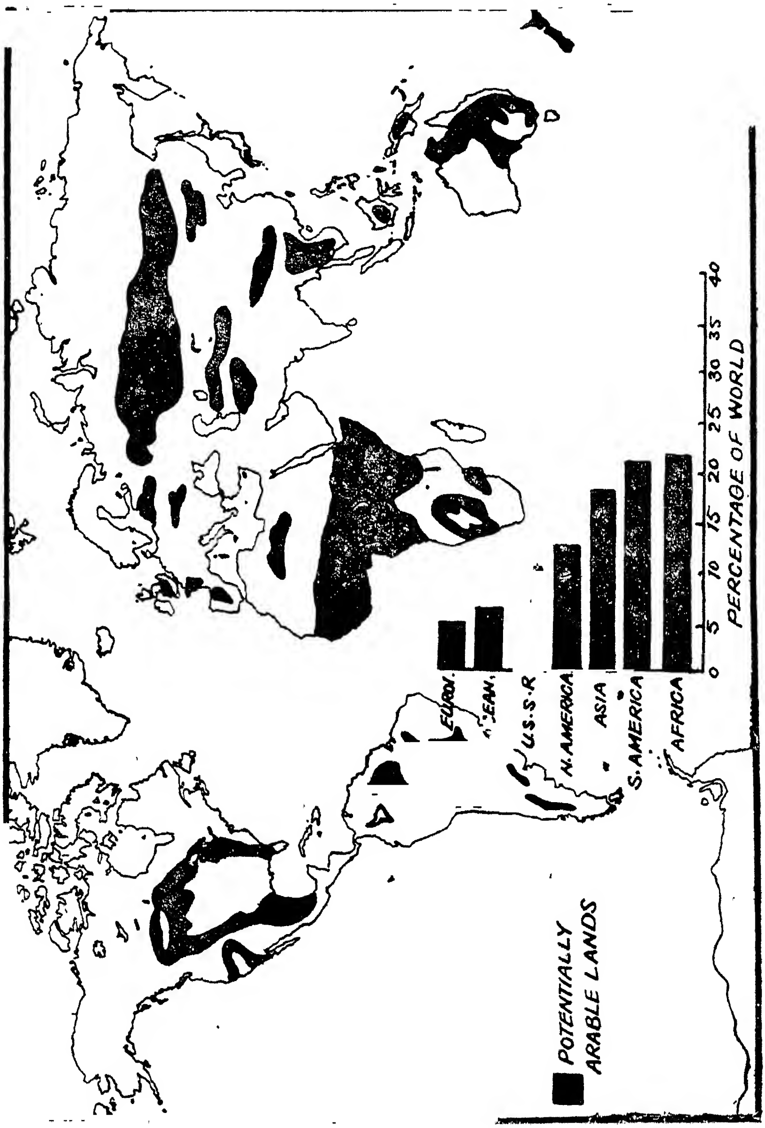


Fig. 20·3. Potentially Arable Lands.

The percentage of "potentially arable land" area varies greatly in different parts of the world depending mainly upon physical conditions of climate, topography and soils. The potentially arable (farmable) land on the earth to be 3·152 billion hectares, as estimated by the President's Scientific Advisory Committee in 1967. About 1·652 billion hectares, more than half of the estimated total lies in the Tropical areas. Warm temperate and subtropical areas account for another 0·548 billion hectares area potentially arable, and cool-temperate areas account for most of the rest 0·894 billion hectares.

The largest "potentially arable" areas exist in Africa (22·9 percent of the whole world), South America 21·4 percent, Asia 19·4 percent, North and Central America 14·6 percent, the Soviet Union 11·3%, and Australia and New Zealand 6·4% and Europe (4·0%) has the lowest under this class. Table 20·3 shows the majority of potentially arable land is in Africa and South America with Asia close behind. Fig. 20·3 shows the Potentially arable lands of the world.

Table 20·3

Percentage of potentially arable land of the World 1967.

Region	Percentage of cultivated land	Percentage of potential land
Africa	16·6	22·9
Asia	30·9	19·4
Oceania	1·8	6·4
Europe	10·9	4·0
North America	18·9	14·6
South America	5·0	21·4
U.S.S.R.	15 9	11·3

Calculations of the carrying capacity of the earth are based on estimates of the quality of food that could be produced and a supposed average daily consumption of calories per individual. Many authors have recalled the Malthusian principle of population of the earth is drawing near the maximum that its resources can support.

Resources for the production of food and organic raw material

Agriculture is now ths most important use of land by man. The problem is to use the land for what it is fit for according to the capabilities of the soil and to raise the soil fertility and moisture and take the maximum output that it is capable of. Man still gets nearly all his food from the soil, less than one percent of what he eats being fish. Apart from the possible development of food-producing resources other than land, the potential food supply depends on the amount of land suitable for food production and on the possibilities of increasing yields per unit of such land.

Sea is a sort of reserve fund. Every year world's population eats about 21 million tons of fish, which is about half as much as the amount of meat we eat from land animals. But the sea is a reserve fund in another way too. It contains all kinds of metals and other valuable substances. Already the very light metal magnesium, used for building aircraft and rockets, is extracted from sea water.

Probably there are a lot of other metal deposits here and there on the sea bottom or just below it. But what there is nobody yet knows, because this is the one part of the world that is still largely unexplored. The day of ocean mining has not yet come, so the seas still often the biggest challenge and the most exciting future on this planet.

Coal, oil and uranium are the principal power generating sub-minerals in persent day world. When they are used up that is the end of them. It seems likely that oil will be first of the fuels to disappear. By the year 2000 we can expect to see gasoline and oil becoming scarcer, but coal should last longer than oil. This is fortunate because many of the jobs done by oil can be down, although sometimes rather less conveniently by coal.

Limitations of Land Resources

There are estimates of the land area of the earth suitable for cultivation. Prasolov has said that less than half of the world's land surface is arable, half the earth's land surface being in the order of 7200 million hectares. Shantz[1] has put the potential crop land of the world at about 6240 million hectares[2]: Zimmermann[3] has estimated that about 40 percent of the total land area, or about 5360 million hectares, may be considered arable; Fawcett gave the figure 4400 million, Alsberg 2560 million, and Pearson and Harper 1040 million[4]. Area presently in cropland and pasture includes only about one quarter of the world's land area. When pasture lands are excluded, the proportion of the earth's land in agriculture becomes minute : only eight percent is in cropland. The cropland of the individual countries is almost as unimpressive. As Baker observed.[5] "Although there is in Siberia a vast expanse of undeveloped arable land, probably as great in amount as the total arable land of the United States, both improved and unimproved; and although there are considerable areas of fertile land as yet undeveloped in Argentina. Australia and other countries of temperate climate, nevertheless, the great reservoir of unutilized agricultural resources is to be found in the Tropics. Tropical and sub-tropical countries include approximately half of the arable

1 Shantz. Agricultural Regions of Africa 1942, pp. 360–361.
2. Zimmermann World Resources and Industries, 1951, pp. 86-87.
3, Fawcett—The Extent of cultivable land, Geog. Jour. vol LXXVI; Alsberg, the food supply in the Migration process, 1937, p. 43;
4 Pearson and Harper. The World's Hunger, 1945, p. 48
5. Baker, O. E., Land utilization in the United States, p 24, Geog Rev. Vol. XIII No. 1, 1923.

land, present and potential, of the world. Of the arable land in these countries less than one-fourth (about 480 million hectares) is in cultivation at present, and possible one eight is used for pasture; whereas in the temperature zones fully one half of the ultimately arable land is now in crops, and almost another third is used for pasture. Apparently the tropics and sub tropics include about three times as large an area of potentially arable land as that which remains undeveloped in the temperature zones."

Carrying Capacity of the Earth

There is always dispute concerning the carrying capacity of the earth. The range of the different estimates is very wide. Penck gave a maximum estimate of 44 0 million and a minimum of 3080 million. Smith in his "*World Population*" has reduced the latter figure to 2280 million. East arrived at a maximum of 2080 millions on the double assumption that 5200 million hectares of land were available for food production and that 1·0 hectare were required per person. According to East "The world has had a continuous natural increase annually for the past century of about 0 7 percent and the increase at present is greater than at any time in the past. My own estimate of this current annual increase of 15 million. In 1800 not a single country had reached a point where the population was pressing heavily upon subsistence in present day terms.........Today the story is different, China is full to overflowing ; India and Japan have passed the saturation point according to western standard of living. The Australians living on the rim of barren desert-bowl and increasing at the rate of about 18 per thousand, a rate which their agricultural possibilities can not stand for long. The United States have reached the point where there are diminishing returns in crop production." Dr. East goes on to say that a careful study of available statistics shows that it takes about 1 0 hectare to support each individual. It is, therefore, necessary to cultivate some 14 8 million hectares more land each year than was ever so treated before...........Take out the mountains, deserts, the undrainable swamps, in short, the areas not available for agriculture and there is left 5200 million hectares (out of 13200 million hectares of land) of this potential world farm, some 2000 million hectares are now being cared for by the hand of man. The total available of 5200 million hectares will support a little over 5000 million people.[1] Dr. East considered the optimism of certain cultivators "who pin their faith to scientific research". He further observes that the true increase in production by more efficient methods of farming... may be as high as 50 percent. But it is offset and marked by the bringing into cultivation of poorer new lands. I cannot see in this prospect anything but temporary expediency. In any per-

1. East, E. M., Popoulation in Relation to Agriculture-in Eugen.cs in Race and State or Mankind, at the Crossroads 1926, pp. 68–69.

manent system of agriculture the soil and the climate are the true arbiters of production.

Salter[1] concluded on the basis of Prasolov's classification of soils ; that the cropland already under cultivation (7760 million hectares, ; according to his estimate) could be increased by 520 million hectares. The potential additional hectrage was distributed as follows : 360 million in South America and Africa, 120 million in the northern part of the northern Hemisphere (principally in North America and the Soviet Union) and 40 million in the islands to the South of Asia.

Baker[2] is somewhat more optimistic, and sums up the problem as regards the whole world in table 20·1. The table 20 1 shows the major land utilization zones of the world. Table 20·3 affords several very useful world figures.

Baker's conclusions, that both the hectrage in crops and the yield per hectare could be increased by 50 percent, imply a maximum of about 1200 million hectares of crop land ; if each hectare can support about one person; on the average, the world's population capacity does not much exceed 4000 to 5000 million persons.

Table 20·1

Arable Land of the Earth[3]

Tropical and Sub Tropical Zones :			
Total Land area	...	59,800,000	km²
Land too arid for crops	...	20,800,000	,,
Land with adequate rainfall	...	39,000,000	,,
Probably one-third ultimately arable	...	13,000,000	,,
Cultivated at Present	...	3,120,000	,,
Arable Land in pasture	...	1,560,000	,,
Potentially arable not used for crops or pastures	...	8,320,000	,,
Temperate Zones :			
Total land area	...	75,400,000	,,
Land too dry for crops	...	19,760,000	,,
Land too cold for crops	...	16,640,000	,,
Land with adequate rainfall and heat	...	39,000,000	,,
Probably one-third ultimately arable	...	13,000,000	,,
Cultivated at Present	...	6,500,000	,,
Arable land in Pasture	...	3,900,000	,,
Potentially arable not used for crops or pasture	...	2,60,000	,,

1 Salter, World Soil and Fertilizer Resources in relation to food needs, 1940, pp. 232–234.

2. Geog. Review, New York, 1923, Vol. XIII No. p. 25

3. Baker, O E., Geog. Rev. 1923.

Dr. Radhakamal Mukerjee[1] is somewhat more optimistic, and sums up the problem as regards the whole world in the following quotation : "The total extent of the unused lands which may immediately be given over to the plough is about 10·92 millions quare kilometre. Of these the peripheral lands fringing China, India and Japan have been fields of successfull agricultural colonization of their land-hungry peasants. There are vast, rich inter Tropical lands which are now taken up by grasslands and forests, whether in South America, Africa, South Asia or Australia, to which entry is, however, restricted or completely barred for Asiatic colonists because of race prejudice or national exclusiveness ; while no kind of economic cooperation of the peoples is forthcoming to extend the agricultural front to the marginal zones, which are too arid, cold or wet......The Prairie provinces of Canada, and the coniferous forest areas in Siberia are still empty......Mongolia is thinly populated ...vast Tropical lands in Central and South America, Africa, Australia and the Islands of the East Indian Archipelago are almost empty." There are many considerable possibilities in Tropical grasslands such as the Pampas of South America. The Savannas of Africa or the animal raising territories of Australia have for greater crops raising potentialities than the Equatorial rain forest. There are vast crops-raising possibilities in Brazil. Friedrich Freise estimates, that the resources of Brazil could support a population of 400 millions, and according to James Bruce,[2] "No country in the world possesses so large a proportion of land available for the support of human life and productive industry." Some years later the writer forecast that with the immense areas in Central and Southern Brazil adapted to cattle raising Brazil seems destined eventually to out strip Argentina, the United States, and Australia, as the greatest purveyor of the world meat supplies." The South America as a whole can support more than 2400 millions which about thirty times her present numbers. The present population in this continent, estimated at 291 millions is found over a total area of the United States of America.

THE POSSIBILITIES OF IMPROVING OUTPUT PER HECTARE

Helleiner has written that "It would be difficult to decide whether man in the course of history has achieved more through making additions to his land, or through improved utilization of the soil."[3] In many countries at present it is evident that increasing yields per hectare is the most effective possible means of increasing the output of both foodstuffs and other organic products. According to Papi (1950), in regions such as the Middle East and the Ear Fast where population is dense and agricultural returns are low, greater production can be obtained only by increasing yields per hectare,

1. Mukerjee—The Political Economy of Population, p. 361.
2. Bryce—South America-observations and Impressions, p 404.
3. Helleiner, Readings in European economic History, 1946, p. 29.

but such increased yield will require considerable investments in capital equipment. Such investment is also the principal requrement in those densely populated areas where yields are already high, such as Western Europe.[1]

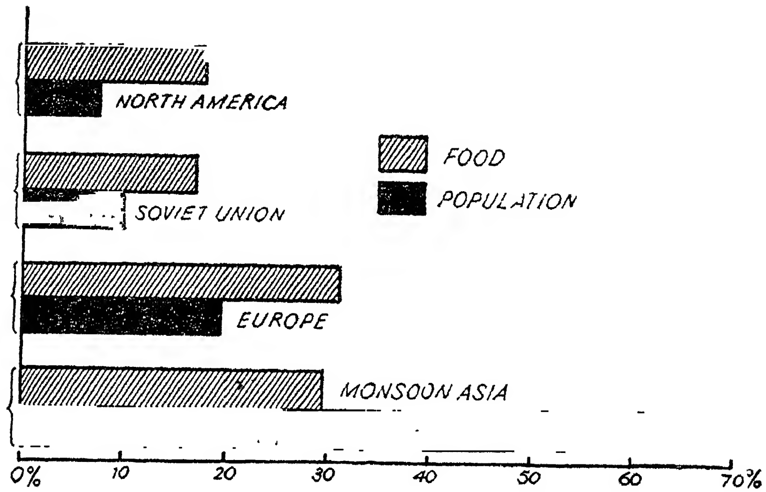


Fig. 20 4. Percentage of Population and Food resources.

Most of the worlds food is grown on land. Fig. 20·4 shows the comparision of food production and size of population in various regions. Suppose that we could take the whole land surface of the earth and give every one an equal share. Each of these pieces of land would be a little more than 5 hectares. But we could not grow crops on all this land, because about half the land area of the world is too cold, too dry or too rocky for agriculture. Another quarter is Tropical jungle and cold forest. The leaves only about 1·2 hectares for each person to grow food on. Two-thirds of this is grassland suitable only for raising sheep and cattle. Each person would, therefore, be left with a mere ·48 hectare for growing his crops.

But this is quite enough if we use it properly. The Netherlands for instance, has the highest standard of agriculture in the world. The food that a Dutchman eats in a year can be grown on only two-thirds of hectare. If each Dutchman were prepared to eat less, cheese and eggs and line on the same sort of diet as a poor African, a plot 30 square metre would provide all his needs.

If all the world's best land were farmed as efficiently as the land of the Netherlands, the earth could support 45 times as many people as it does now. And if the world's population were smaller,

1. Papi, Developing economies of undeveloped regions, 1950, pp. 11—13.

everyone could eat better. All this could be achieved simply by using modern farming methods in those parts of the world where the ground is uncultivated or scratched only by wooden ploughs.

Human beings cannot live on grass because it contains a lot of woody substance (cellulose) that we cannot digest. Since grass is an easy crop to grow we can turn grass into food for humans by using a machine that breaks down the cellulose and allows the protein, the most valuable part of the food to be squeezed out. Wood as a source of both stock and human food, as well as of industrial alcohol and a large series of organic chemicals, is likely to increase greatly in importance if the yields from the world's forests that are attainable with good management are approximated in the future. Studies of photosynthesis have received a new impetus with the recently available radio-isotopes; there are now scientists who think that the synthesis of carbohydrates from inorganic materials many occur in the not too distant future, and that the industrial production of such algae as *Chlorella,* strains of which have been selected for their extraordinary oil or protein content, for human food awaits essentially only suitable economic conditions.

Non-Ecumene Lands

The non-ecumene lands of the world may be described under four heads as shown in Fig. 20 5 they are—

1. **Cold Lands**—These are located roughly within the Arctic and the Antarctic circles. Nearly the whole of Greenland and the adjacent islands as well as the northern fringes of Canada, Alaska, Scandinavia and Siberia entere into the Arctic Circle and thus constitute the Tundra or cold desert Regions of the northern hemisphere. In Southern Hemisphere the continent of Antarctica falls almost entirely within this category.

2. **Hot Deserts**—Areas within the hot deserts which are almost rainless possess arid Tropical climate and are commonly called Tropical deserts. There are seven of these in the world : the Sahara and the Kalahari in Africa, the Thar and Arabia in Asia, the western Australia. the Atacama—Peruvian coastal areas in South America, and the Colorado-Sonora bordering the Gulf of California in North America. There are many assumptions about the nature of the Hot desert as a type of human habitat, some of which are the following—

that it is completely dry ;

that it is a monotonous expanse of sand ;

that it is practically devoid of plant and animal life, and that it is constantly hot or warm regions all the round.

3. **Hot Wet Forest**—The main regions lying within this belt are : the Amazon basin of South America, the Congo basin of the central Africa and East Indian archipelago with the adjacent areas of the mainland. Within this belt, the region is hot and damp, and

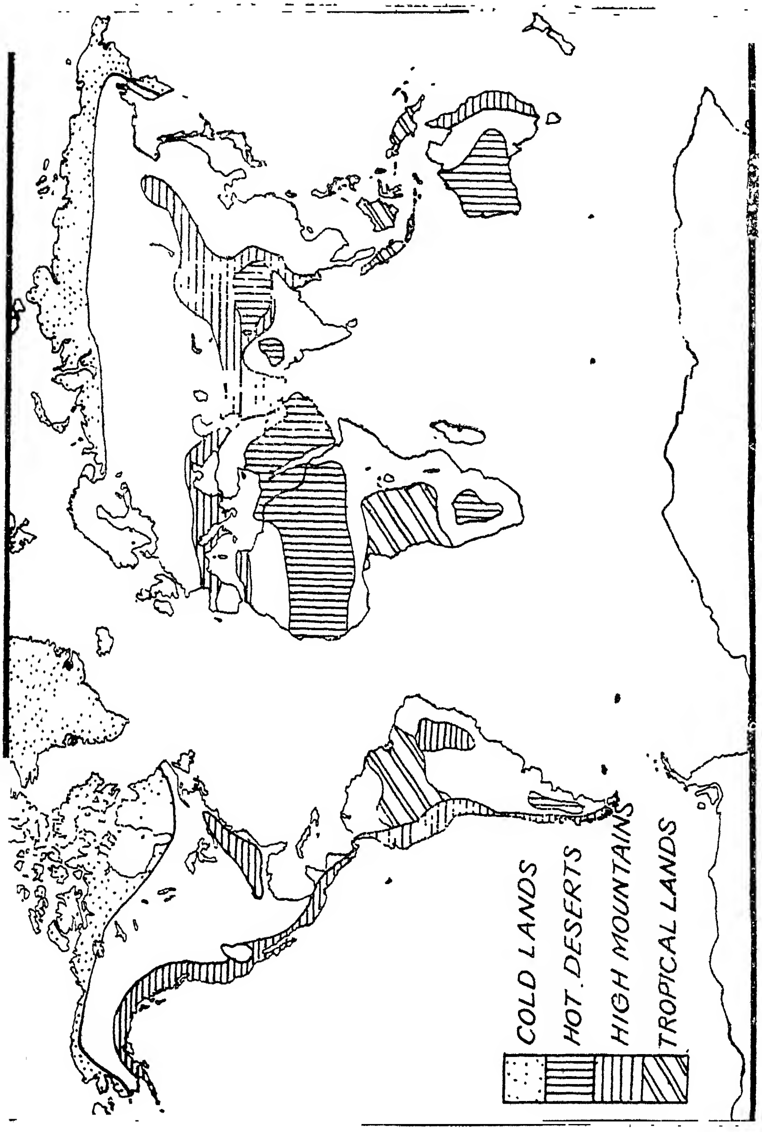


Fig. 20·5. Non Ecumene Lands of the World.

winds are feeble or absent for long periods of time. Rainfall is supplied almost entirely by convection circulation. Extreme of temperature, rain, animal and plants have prove the region is unfavourable for human habitation and progress.

4. High Mountains—The high mountains are, generally speaking, the non-ecumene lands of the world. The high mountains greatly decrease the area of habitable land (1) by their own ruggedness and inhabitability, (2) by the aridity on the leeward side of the high mountains.

PART VII

AGRICULTURAL RESOURCES

CHAPTER 21

AGRICULTURAL RESOURCES

General Pattern of World Agricultural Resources

The land area of the world is limited, and the arable land is still more limited. Because of climatic or topographic conditions, only 40 percent of the total area of the world can ever be used for crops, and most of this arable land is already so used. On the other hand, the population is inherently unlimited and is increasing at the rate of about ten million a year. During the twentieth century the population of the world increased from 2969 million in 1930 to 3706 millions in 1971. The world is getting more and more crowded with a total population of over 3706 million an increase of almost one-sixth since 1950. Population census taken during 1961–1971 showed an average growth rate of 1·8 percent a year in the world's population. The problem of ever increasing pressure of population on limited land resources looms large. Poland and Japan have made substantial progress in planning their land resources. Below one hectare of land in Japan supports 4 to six person while in India it supports one person at the inadequate level of nutrition. Table 21·1 shows the pressure of population per hectare.

It is estimated that for every ten million increase in population,

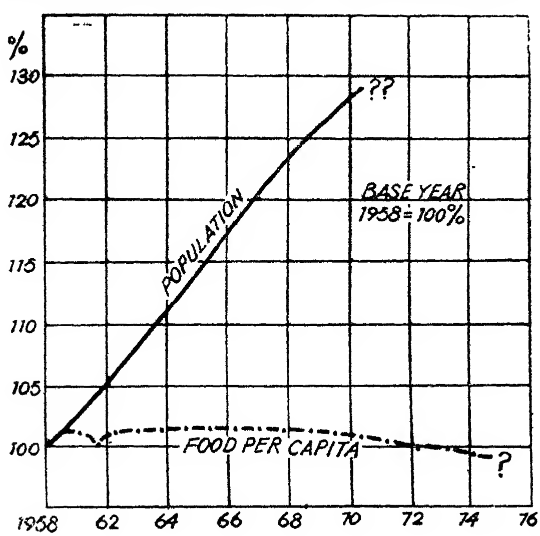


Fig 21·1. Food supply in relation to Populat'on Growth.

Table 21·1

Pressure of Population per hectare in selected countries[1]

Per hectare highest productivity	Population Pressure	Medium Productivity	Population Pressure	Low Productivity	Population Pressure	Lowest Productivity	Population Pressure
Egypt	9·5	Sweden	1·7	Thailand	2·4	Tunisia	0·80
Netherlands	4·9	France	1·3	Yugoslavia	1·2	Brazil	0·50
Taiwan	10·5	Austria	1·7	Burma	2·4	Honduras	0·54
Belgium	5 0	Finland	1·5	Greece	0·9	Morocco	0·69
Japan	13·3	U.K.	2·7	U.S.A.	0·4	Syria	0·37
Denmark	1·4	Indonesia	4·6	Chile	1·1	Uruguay	0·19
W. Germany	3·6	Portugal	2·1	India	2·4	Argentina	0·14
Malaysia	3·0	Philippines	3·4	Canada	0·3	Mexico	0·27
S. Korea	11·7	Isreal	1·7	Iraq	1·0	Algeria	0·20
Sri Lanka	6·4	Ireland	0·6	Iran	1·1	S. Africa	0·15
Norway	3·4	Pakistan	3·2	Colombia	0·7	Venezuela	0·30
Italy	2·3	New Zealand	0·2	Turkey	0·5	Ethiopia	0·28
Switzerland	2·4	Spain	1·4	Peru	0·8	Australia	0·02
Total	5·9	Total	2·0	Total	1·2	Total	0·34

1. UN : FAO, The Sta e of Food and Agriculture 1963, p. 111.

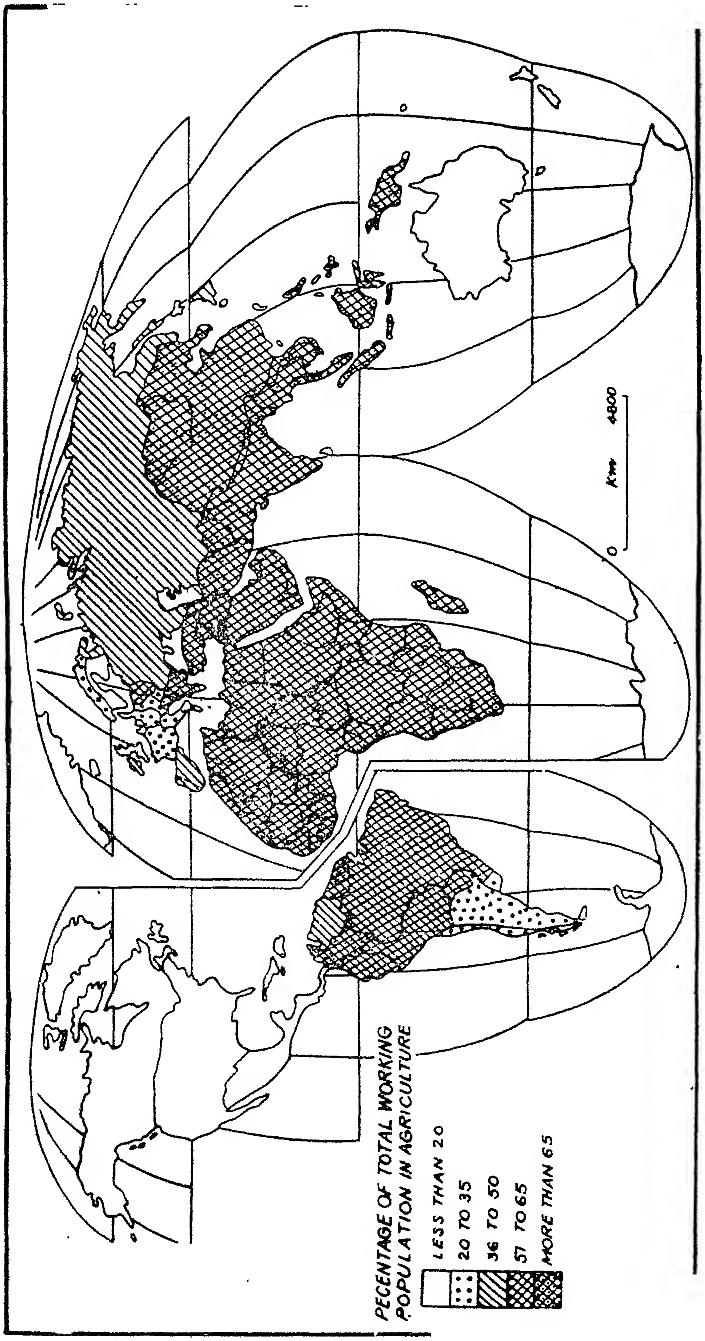


Fig. 21·2. Percentage of Working Population in Agriculture.

we have to provide a total of some two million tons of additional food grains, half a million tons of fruits and vegetables and about a million tons of additional animal products mostly milk. Only in India, as the annual rate of increase in population is of the order of 10 millions, the annual food availability has to be raised by four and a half million tons in terms of economic grain equivalent merely to satisfy the needs of additional population. Fig. 21·1 shows the growth of population in relation to food supply.

The problem poses a great challenge to Government and world thinkers.

France has found a temporary solution, at least, in limitation of population ; England, in industrial development and the exchange of manufactured goods for food and raw materials from other lands ; while Germany has followed England's example and also, in greater degree than France or England, had achieved notable increase in the productiveness of the land. At the beginning of twentieth century, these three nations have tried the old remedy of retarting population growth by war, while Peoples Republic of China has added to the horrors of war the even more effective method of famine. He who surveys the developing world, whether he look at Africa, Latin America or Asia, will see dominating the entire economic and social situation this great problem of food supply and of efficient utilization of the land.

The demands of growing population are likely to be met by more intensive use of the better land rather than by the extension of crop production into the poorer lands. The cultivation of this greatly increased hectarage of crops was accomplished by an apparently decreased number of farmers and farm labours in many countries of the world. The number of persons engaged in agriculture decreased in many developing countries due to better utilization of natural resources. Percentage of total working population in agriculture is shown in Fig. 21·2. Table 21·2 shows the percentage of total working population in agriculture.

Table 21·2

Percentage of total working population in Agriculture

Region	1950		1960	
	Total ten Million	Percentage	Total ten Million	Percentage
World	68·4	64·1	73·8	57.8
Developed Countries	12·9	—	10·9	—
Europe (Excluding U.S.S.R.	6·6	36·6	5·5	28·6
U.S.S.R.	5·2	55·8	4·6	42·1
North America	0·86	13·0	0·55	7·2
Oceania	0·17	31·4	0·18	27·7

Developing Countries	55·5	—	62 9	—
Africa	7·4	80·6	8·3	76·6
Asia	45·1	78·9	51·2	71·9
Latin America	3·0	53·2	3·4	47·9

Source : F. A. O. Publications.

We still have about 3001 million hectares, an amount one-half of the present hectarage of improved land, which it is possible by various means of amelioration to bring into use for crops. This area, mostly scattered in small tracts in various parts of the world, consists of about 1208 million hectares of pasture land in develpoed countries of the world and probably 1793 million hectares of land in developing countries, which can be reclaimed when the price of agricultural resources justifies the cost ; also there are perhaps 4000 million hectares of forest and cut-over lands, not requiring crops after clearing ; and about 3000 million hectares of stony or infertile land of, the world, the use of which for crops is not justifiable at present prices of agricultural products and labour.

The cultivated crop land of the world is unevenly distributed relative to the population as shown in Fig 21·3. Table 21·3 shows the per capita holding of agricultural land with population density per sq. km.

Table 21·3

Per capita Agricultural holding and density in 132 selected countries*

Density per km².	**No. of countries**	**Per capita holding in hectares**					
		0·0 to 0·19	**0·20 to 0·39**	**0·40 to 0·59**	**0·60 to 0·99**	**1·00 to 1·99**	**more than 2·00**
Total	132	31	29	29	23	12	8
0 to 9	33	2	7	7	6	4	7
10 to 24	30	1	5	10	10	3	1
25 to 49	18	1	3	4	5	5	—
50 to 99	16	4	6	4	2	—	—
100 or more	35	23	8	4	—	—	—

The amount of cultivated land per person is relatively high in much of Oceania and the Western hemisphere, and low in Europe and Asia as shown in Table 21·4.

* F.A.O. Production Year Book & UNO Demographic Year Book, 1970 ; 1971.

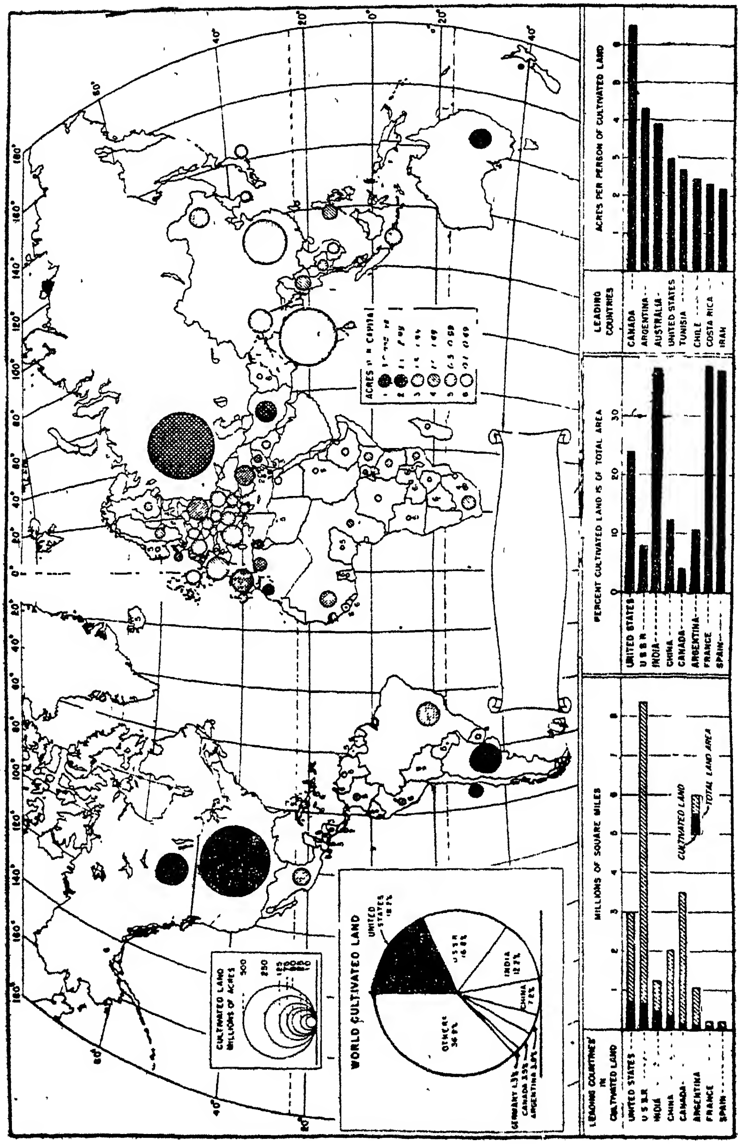


Fig. 21·3. Total and per capita cultivated Land

Table 21·4

Per capita holding of Agricultural land and per hec. production*

Region	Per capita holding of Agri. land (hectares)	Per hectare Production (hundred kg.)			
		Wheat	Rye	Barley	Oats
World	**0·39**	**14·8**	**15·4**	**16·5**	**16·5**
Developed Countries					
Europe (excluding U.S.S.R.)	0·35	24·6	19·5	27·1	23·4
U.S.S.R.	0·97	14·4	13·6	13·0	12·9
North America	0·98	20·3	15·3	27·6	18·1
Oceania	2·49	11·7	5·1	11·3	9·1
Developing Countries					
Far East (excluding China)	0·24	12·0	14·0	13·5	10·4
Middle East	0·46	10·2	10·8	9 0	12·1
Africa	0·65	7·6	4·3	8·4	5·1
Latin America	0·45	13·6	7·2	10·1	11·8

Similar disparities appear when the total arable land is considered, rather than the land actually being cultivated ; but the magnitude of the differences is uncertain, because it depends on the definition of cultivable land and on the varying estimates of the amount of it which is available in each continent. Table 21·5 shows the population and arable land areas of the world. On the whole, the distribution of uncultivated potential crop land is not such as to counterbalance the unequal distribution of land under cultivation. Salter's estimate of 2080 million hectares of unused land suitable for crops, for example, includes only about 260 million hectares in Asia, outside the Soviet Union.[1] This estimate may be too small,[2] but it seems that relatively little can be done to improve Asia's food supply by extending the area of cultivation in

* FAO Production Year Book. Vol. 24, 1971.

1. Salter, World Soil and fertilizer resources in relation to food needs, 1948, pp 232–234.

2 According to Lee, in China alone only a little over one-half of the estimated 1300 million hectares of cultivable land is under Cultivation; but he does not believe that it will be cultivated unless Chinese agriculture is mechanized and modernized. Lee, Pattern of Land utilization and possible expansion of cultivated area in China, 1947.

Table 21·5

Population and Arable Land Areas*

Region	Population 1971 (million)	Million Hectares: Total Land	Total Arable Land	Land under plough	Permanent pasture land	Per capita (hectares): Total Land	Arable Land	Under plough
World	3706	13,392	4425	1424	3001	3·67	1·2	0·39
Developed Countries	960	5552	1856	648	1208	—	—	—
Europe (Excluding U.S.S.R.)	466	493	241	148	93	1·08	0·53	·35
U.S.S.R.	245	2240	608	233	375	9·32	2·53	0 97
North America	229	1968	500	220	280	8·77	2·23	0·98
Oceania	20	851	507	47	460	45·01	26 81	2·49
Developing Countries	2746	7840	2569	776	1793	—	—	—
Far East	1057	1117	384	274	110	0·99	0·34	0·24
China	850	956	287	110	177	1·15	0·35	0 13
Middle East	194	1207	264	77	187	7·26	1·59	0·46
Africa	354	2503	1009	192	817	8·41	3·39	0·65
Latin America	291	2057	625	123	502	7·46	2·27	0·45

* FAO Production Year Book, 1970, Vol. 24. (1971).

that part of the world. Salter placed 390 million unused hectares in the Northern hemisphere, chiefly in places which are not readily accessible to the peoples of the earth's crowded regions. The uncultivated lands in Africa and South America, which he estimated at 1170 million hectares, may provide space for future expansion of the population now living on those continents, and perhaps for a considerable number of emigrants from Europe ; but at least under present conditions such lands are virtually closed to the peoples of Asia.

Agriculture is the oldest and most important industry of the world. Leaving out China, there is no country in the world in which so many people depend on agriculture for their livelihood as in India. About 70 percent of the total Indian population is engaged in this industry. Yet, in spite of it, the present day agriculture in India cannot be said to be a scientific agriculture.

The two outstanding features of agricultural production in developing countries are the wide variety of crops and the preponderance of food over non-food crops.

Most of the cultivated area lies in the great plains of the world and coastal areas. More than eighty percent of the area of these plains is under the plough. The remaining part of the cultivated area lies scattered in the plateau and hilly regions where the Grey-brown soil region is the most important. An important feature of the plateau region is the large proportion of cultivable area left as fallow. Africa, Latin America and Australia and some parts of Asia showed the largest area of fallowland or seasonal grazing. A certain part of the agricultural area of especially irrigated land of the world is cropped more than once in the year.

Of the gross cultivated area in 1970–71 roughly about 4400 million hectares was occupied by food crops, leaving only a small percentage for commercial crops like Cocoa, Coffee, Cotton and oilseeds etc. The gross hectarage under important crops in recent past has been as follows.

Table 21·6

Hectarage under Crops Area (1,000 hectares)*

Crops	1961–65 (Average)	1969	1970	1971	1972
Wheat	210,894	220,984	210,422	216,455	214,673
Rye	27,839	19,031	18,732	18,733	17,025
Barley	68,313	77,489	78,088	79,590	84,745
Oats	33,405	32,088	32,488	31,329	31,215
Maize	99,717	104,417	107,072	111,425	108,584
Rice	123,566	133,220	134,152	134,307	130,030
Millet	68,810	70,040	69,402	68,176	66,786
Sorghum	38,079	41,691	41,572	42,624	38,133

* The Statesman's Year Book 1974–75.

Table 21·7 gives the production of principal crops of the world for various years.

Table 21 7

Production of Important Food Crops.*

Crops	Average 1961–65	1969	1970	1971	1972
		1,000 metric tons			
Wheat	254,302	314,757	318,302	353,899	347,621
Rye	33,833	29,218	27,634	31.693	28,403
Barley	99,703	136,856	139,450	151,473	152,673
Oats	47,818	55,138	55,315	57,749	51,316
Maize	216,617	266,181	261,149	304,978	304,354
Rice	253,063	223,448	306,175	307,147	291,784
Millet	38,199	44,493	47,501	45,480	41,851
Sorghum	35,604	45,277	44,453	50,930	45,118

Comparison between Developing and Developed countr es Agriculture

Agriculture in developing countries is characterised by certain features which are not met within the agriculture of the developed countries of the world. There are requirements of factory workers dominate agricultural production. The important features of agriculture of developing countries are :

Most of the land in developing world is devoted to the cultivation of foodgrains. About four-fifths of the cultivated area of developing countries are under food crops.

There is no crop which is grown for the specific purpose of providing fodder for cattle or other animals Cattle fodder in developing countries and especially in monsoon lands is largely a by product of the food crops. In most of the developing countries cultivators as a rule neither buy nor sell fodder ; they know what they can expect to obtain from the common waste, and they plan their crops in such a way that the yield of fodder (whether principal or secondary product) together with the yield of the waste, will make up their requirements. The practical equilibrium of fodder supply in developing countries does not exist only with reference to the number of efficient cattle required for tillage just like in monsoon lands. There are also the cattle that are part of regular work for which there is no regular market, and which are protected from destruction by a religious sentiment humane in its origin though resulting in a large amount of suffering. Many cattle in developing countries are not wholly unproductive, or rather it is impossible to draw a line between useless and productive animals. Though past regular work, the have to help when work is pressing and it is a common sight to see an almost worn-out bullock taking a short turn at the well while an efficient bullock has a rest.

In most of the developed countries where land formerly used

* Ibid

by cultivators for grazing (as in north America) comes under the plough, it yields in any case a fair share of fodder as secondary product, and apart from this, the cultivators who formerly depended on the grazing will grow crops that yield more fodder so as to make up the deficiency. It is true that in some cases, such as the substitution of millet for cotton, this would be unsatisfactory; but the more probable adaptation is an extension of wheat growing : while where canal water is available and holdings are sufficiently large the adoptation will be effected by growing crops exclusively for fodder.

The idea of cultivated land going back to grazing will appear so unfamiliar at first that it is advisable to explain the mechanism of the process [1] Leaving out of account the moorland as not likely to be of much use either for cultivation or for grazing, all the land of the U.K may be regarded as arranged in series according to its suitability for cultivation relatively to grazing, suitability being determined by situation as well as other natural qualities. Thus the market gardens round London (to take a conspicuous example) stand at the head of the series because they are so suitable for gardening that their value for grazing could not be greater in any conceivable circumstances. At the other end of the series stand such lands as the hillsides of Pennine Chain or the Scottish uplands, where cultivation is so nearly out of the question that their maintenance for grazing seems assured. And between these two extreme lies the rest of the land of United Kingdom, which could be used either for cultivation or for grazing, and which will in the long run tend to be used for which ever purpose promises the larger profit.

In developing countries the use of manures is very scanty and haphazard. Most of the animal refuse which gives the best all round manure, is burt as fuel, owing to the scarcity of forests in the important agricultural areas of India, Bangladesh etc. The amount of chemical manures are comparatively small.

In developing countries the yield per hectare, therefore, is very small in comparison to developed countries as shown in table 21 8.

Table 21·8

Per hectare yield in selected countries yield in 100 kg.

Selected crops	Average	High yield countries	Low yield countries
Wheat	10·7	42·7 Denmark	3 2 Burma
Rice	18·4	57·4 Spain	6·3 Puerto Rico
Barley	12·9	40 6 Netherlands	2·3 Tunisia
Rye	11·1	29·2 Netherlands	3·1 Australia
Oats	12·4	33·3 Denmark	4·1 Portugal

* Stamp L.D., The Land of Britain— ts use and misuse and Applied Geography, 1960

Animals are mostly used in agricultural operations, for example, the Indian bullocks on whom falls the whole of the agricultural work are weak and puny creatures who cannot pull big ploughs, necessary for deep ploughing. As contrasted with the scientific agriculture of developed countries, the backward agriculture of developing countries produce more than one crop in the same field. Severe losses occur in agriculture in developing world owing to droughts as the irrigation facilities are inadequate. The productivity of different crops is very low in developing countries in contrast to developed countries. The table 21·9 shows the productivity of principal crops in selected countries.

Table 21·9

Average yield per hectare in lbs.

Country	Yield
1. Paddy	
Japan	3,750
China	2,387
Burma	1,420
U.S.A.	3,030
Thailand	1,565
India	1,209
Pakistan	1,244
Egypt	4,628
2. Barley	
Denmark	3,148
Japan	2,157
France	1,713
U.S.A.	1,297
Iraq	817
Morocco	774
India	748
3. Wheat	
France	1,872
Canada	1,512
U.S.A.	1,201
Australia	975
Argentina	1,153
Egypt	2,091
India	640
Pakistan	656

4. Maize	
Italy	2,143
U.S.A.	2,463
Egypt	1,987
Argentina	1,541
France	2,447
Pakistan	948
India	732
China	1,169
5. Sugarcane	
India	29,095
Pakistan	27,000
Indonesia	68,695
China	35,438
Hawaii	177,515
Egypt	78,341
Cuba	36,644
U.S.A.	48,439

Agriculture in developed countries not only to provide food for such a large population, but has also to provide the means with which to provide other requirements of life.

Of the total area of the world, roughly 35 percent is cultivable. About 31 percent of the total area, however, is left follow every year and only about 34 percent is, therefore, the total net area sown annually. A little less than one-half of the total sown area of the world lies in the plains and coastal regions.

More than two-thirds of the area sown in temperate zone is occupied by the four crops, wheat, rye, oats and barley. Among other important crops are the sorghum and sugarbeet, while in Tropical world rice, sugarcane, cotton and oilseeds etc. are mostly grown.

Classification of World Agricultural Resources

There are two well-defined food agricultural resources. They are:

1. **Resources of Kharif Season**—The major resources of *Kharif* season are rice, jawar, bajra, maize, cotton, sugarcane, groundnut etc.

2. **Resources of Rabi Season**—The major resources of *rabi* season are wheat, barley, gram, linseed, rape, mustard etc.

Following are important food resources :

1. FOOD RESOURCES

Rice

Rice is by far the most important food resource in monsoon

lands from the point of hectarage and the number of people it supports. Rice is a special crop of the monsoon lands where alone it finds almost ideal conditions for its growith.

Ecological conditions :

Sufficiently high temperatures, high rainfall and fertile alluvial plains, this combination is seldom met with in any other climatic region of the world. Besides these ecological combination, the monsoon lands are densely populated areas with abundant supply of cheap labour. For it must be realised that rice cultivation is not suited to mechanical cultivation. It needs plenty of hand or human labour. But water is the limiting factor in the cultivation of rice in most of the areas of the world. In Japan, China and Burma, mountain slopes have been terraced or marshes drained to make rice farms wherever water is enough for the needs of rice. Where rain water is not enough for rice, but where rice must be cultivated for some reason or the other, irrigation has to be provided. In general, it can be said that rice needs plenty of heat, plenty of rain or irrigation water, plenty of labourers, and plenty of alluvium to give plenty of food for plenty of people. There is no other food which is so plentiful in densely populated areas of Asia as rice, but rice is staple crop of monsoon landers hence a shortage of food is generally observed.

Geographical Distribution

Monsoon Asia is the largest producer of rice in the world. Almost in every country rice accounts for more than 40% of the sown area. Most of this rice is obtained from autumn crop which is sown in June and harvested about October or November.

South east Asia provides another requirement of rice cultivation in its uniformly high temperatures. But a high temperature is not so essential as high rainfall. For rice is cultivated on the slopes of the Himalayas even on heights of 2438 metres or so above sea-level where temperature are not high. Fig. 21·4 shows the main rice growing regions of Asia.

Except China, about which reliable statistics are wanting, India produces and perhaps consumes also the largest amount of rice in the world. Most of the Indian supplies come from West Bengal, Orissa, Madhya Pradesh, Andhra and Tamil Nadu.

Rice is considered generally as a winer crop in India, as over the whole of the country it is harvested mainly from November to January. The sowing lasts from April to August for most of the varieties grown in India.

The rice season in Bengladesh varies greatly. The first crop is sown between May and December and gathered from September to April. The second crop is sown between October and March and harvested between January and June.

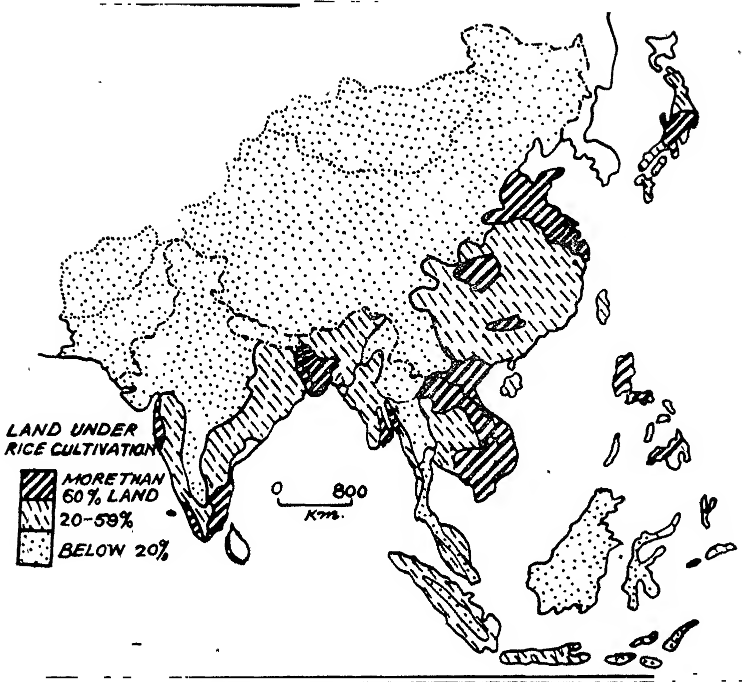


Fig. 21·4. Rice growing regions of Asia.

The three crops of rice in Bangladesh and the neighbouring areas are given in table 21·10.

Table 21 10

Rice crops in Bangladesh

Crop	When sown	When transplanted	Harvesting period
1. Aus	April-May	Sown broadcast	August-September
2. Aman	June	July-August	November January
3. Boro	October	December	March

The rice crop in Bangladesh and in other adjacent areas where irrigation is not much practised, is damaged to some extend by the vagaries of rainfall. The rice crop of Bangladesh and Western Bengal is also sometimes damaged by untimely floods. These floods fill the depression along the river with water which cannot be used for sowing the rice crop, as the water does not dry up in time for sowing.

Rice cultivation in Asia is done almost without any manuring

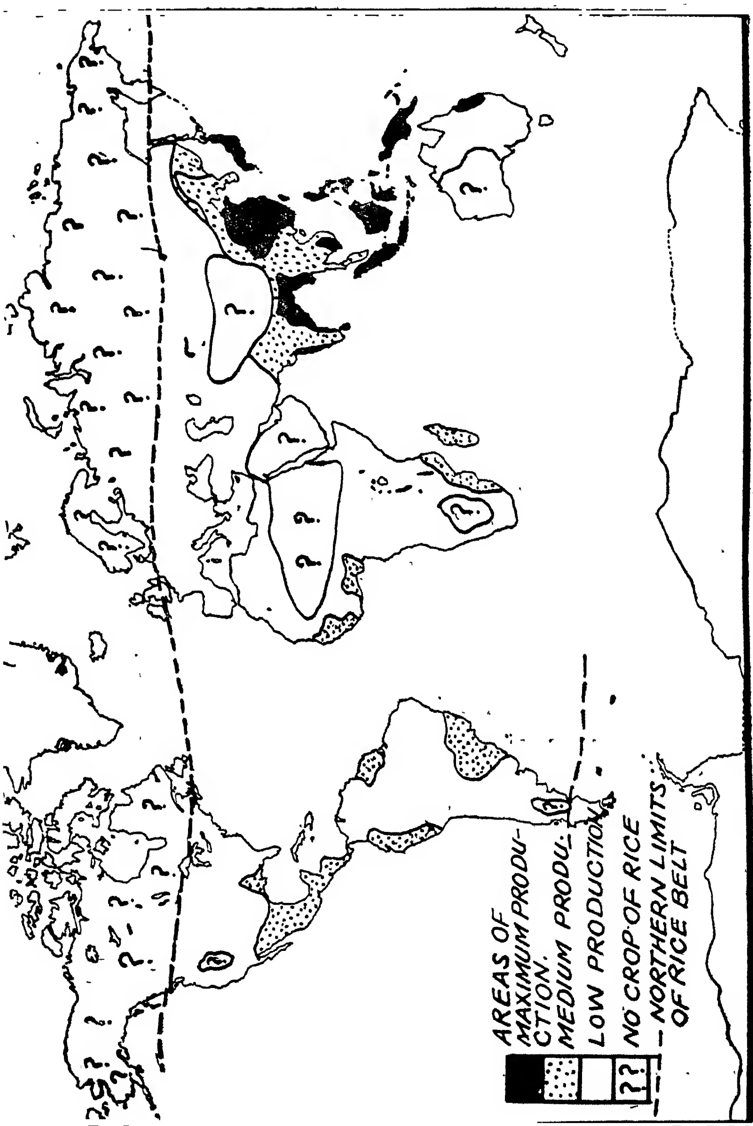


Fig. 21·5. Rice Growing Areas of the World.

of the fields. It is only recently that green manuring is being advocated. Fortunately, however, large parts of South and South east Asia are subjected to river floods resulting in considerable deposits of silt which help the land to regain fertility.

The distribution map of rice (fig 21·5) shows that there are two areas of the world which grow practically no rice. These are the northern cold area and the desert or semi desert areas of the world. These areas do not have enough water or temperature for rice cultivation.

In Pakistan rice is grown in the canal-irrigated areas of Sind Sagar doab and Bari doab during summer only.

Rice is also important in Peoples Republic of China, as well as in the mountain river valleys. Red Basin is an important producer. Rice is a China's premier crop. In prewar year 1931–1937, it covered about 20,000,000 hectares, with a yield of 50,000,000 metric tons of poddy. Surplus rice is available in the mid Yangtze lake plains around Changsha, Nanchang and Wuhu and on Taiwan. The deltas around the coastal cities from Tientsin to Canton are all deficient areas.

Other areas where rice crop covers over 40% of the sown area are Vietnam, Laos, Combodia, Philippines and Indonesia. In Malaya also it is an important crop.

In Burma, the coastal districts and the Submontane districts are the chief producer of rice. Rice is, however, also cultivated to some extent in the canal-irrigated areas. There is only one crop of rice raised here. Fig 21·6 shows the length of growing reasons of the world. Sri Lanka is also important rice producing country of Southern Asia.

Hectarage and Production

Rice is grown in almost all the Tropical countries of the world, but its cultivation is mostly concentrated in the river valleys, deltas and low lying coastal areas of south and south eastern Asia. which together they contribute about 85% of the world population.

Of an area of about 1194 lakh hectares under rice cultivation at the end of 1961–62, nearly 90 percent is located in monsoon Asia. The following table 21·11 shows the hectarage under rice crop. Nearly 29% of the cultivated area lies in India, and about 28% in Peoples Republic of China, followed by Bengla desh (and Pakistan) 8% ; Indonesia 6%, Thailand 5%, Burma 3% and Japan only 2% 3% in Latin America, 2% in Africa and ·05 in Europe, while rest of the world 13%.

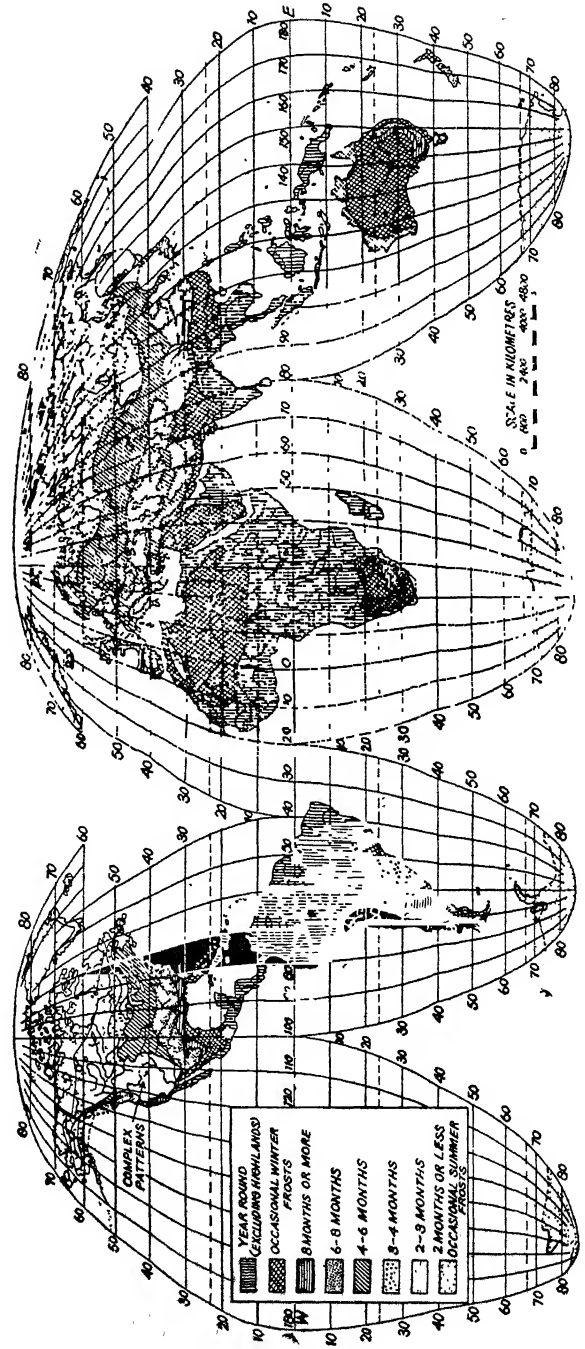


Fig. 21 6. Length of Growing Season.

Table 21·11

Hectarage under rice crop (Figures in Lakh hectares)[1]

	1948–53 average	1961–62	1971–72
World	1025	1194	1303
Asia	960	1101	—
China	268	315	337
India	303	336	360
BenglaDesh	—	—	—
(incl.) Pakistan	90	97	148
Japan	30	33	25
Indonesia	59	68	79
Thailand	52	57	65
Burma	38	41	48
Others	122	154	—
S. America	24	38	—
Brazil	19	30	48
North and Central America	11	14	—
U S A.	7	6	7
Europe	3	3	—
Africa	27	28	—

From the statistics we learn that out of the total production of 32 8 lakh metric tons of rice Asia produced 92 percent, South America 3·2 percent, Africa 2·3%, north and Central America 1·8 percent Europe 0·6% and Oceania 0·1 percent. The Table 21· 2 shows the production of rice in selected countries since 1968.

Table 21·12

Production of rice (Figures in lakh metric tons)[2]

	1968	1970	1973
World	2851	2056	3218
Asia	2598	2794	2944
China	920	1052	1090
India	596	633	656
Bengladesh	162	167	194
Pakistan	28	33	35
Japan	188	165	158
Indonesia	155	178	216

1. FAO Production Year Book 1962. The Statesmans Year book 1975–76.
2. FAO Production Year Book and Statesmans Year Book 1975–76.

Thailand	109	133	147
Burma	85	82	86
Others	—	—	361
South America	92	103	104
Brazil	67	75	76
Africa	71	74	73
Egypt	26	26	23
Malagasy	18	19	18
Central and N. America	61	52	57
U.S.A.	48	38	42
Europe	15	18	20
U.S.S.R.	—	—	18
Oceania	—	—	3·4

World Rice Trade

Japan was the leading world exporter in 1971 to 1974 and was followed by Thailand, Burma, Cambodia and Taiwan. China is self-sufficient in rice production. Table 21·13 shows the trade of rice since 1971.

Table 21·13

Rice Trade (Figures in lakh metric tons)

	Exports		Imports	
	1971	1974	1971	1974
Developing countries	37·9	38·0	61·7	64 8
Asia	28·2	27·0	41·3	42·3
India	—	—	2·4	1·2
Indonesia	—	—	5·1	11·0
Bengladesh	—	—	4·0	4·0
Vietnam	—	—	1·4	4·0
S. Korea	—	—	10·1	4·0
Cambodia	0·3	—	—	2·0
Philippines	—	—	4·4	4·0
Malysia	—	—	2·5	1·0
Sri Lanka	—	—	3·4	2·0
Hongkong	—	—	3·4	4·0
Singapore	—	—	2·3	2·6
Thailand	15·7	15·0	—	—
Burma	8·1	4·0	—	—
Taiwan	0·5	0·1	—	—

Pakistan	2·0	5·0	—	—
Developed Countries	**30·3**	**30·2**	**8·8**	**8·0**
North America	14·8	20·0	1·4	1·0
W. Europe	4·6	4·0	6·4	6·9
Japan	9·1	4·0	—	—
Oceania	1·1	2·2	1·0	1·0
Middle East	5·2	5 5	5·8	7·0
Africa	0·5	0·5	9·5	10 0
Latin America	4·0	5·0	5·1	5·5
Planned Economy	9·0	10·0	6·0	6·0
China	9·0	10·0	—	—
World	**77·2**	**78·0**	**76·5**	**75·0**

WHEAT

Wheat is the most important commercial agricultural resource of temperate lands. It is important in areas in which rice is not important, because the climate and soil requirements of the two grains are different.

Ecological Requirements

Although wheat grows in many countries of the world, for the period of its early growth it must have moderate rainfall with rather cool, moist weather, long continued if possible. This must then be followed by warm, bright and preferably dry weather. Wheat requires a fertile loam or any other fertile soil, provided it is not too wet. It grows best in a cool, moist climate and ripens best in a warm, dry climate. The ideal wheat climate is that wherein the annual rainfall is between 50 to 75 cms; the winter temperature is between 4°C to 9°C, and the summer temperature varies between 15°C to 20°C

Although wheat is grown in many climatic regions, most of the important areas of wheat production have an annual precipitation of less than 76 cms. Some wheat is even grown in areas receiving as little as 15 cms rainfall per year just like in Panjab and Pakistan, where there is ample facilities for canal water.

It may be said generally that wheat cultivation of the world increases from the Equator to the south and northwards, that is to say, on leaving the humid atmosphere and the inundated soils of the south and the east. Wheat is practically absent in clay and red-yellow soils. The other area without wheat cultivation is the hot and cold deserts.

Geographical Distribution

A study of the geographical distribution of wheat in the world reveals that it is grown mostly in the alluvial soils of temperate regions. A special feature of the wheat crop of tropical part is that unlike that of the cool temperate countries of the world where

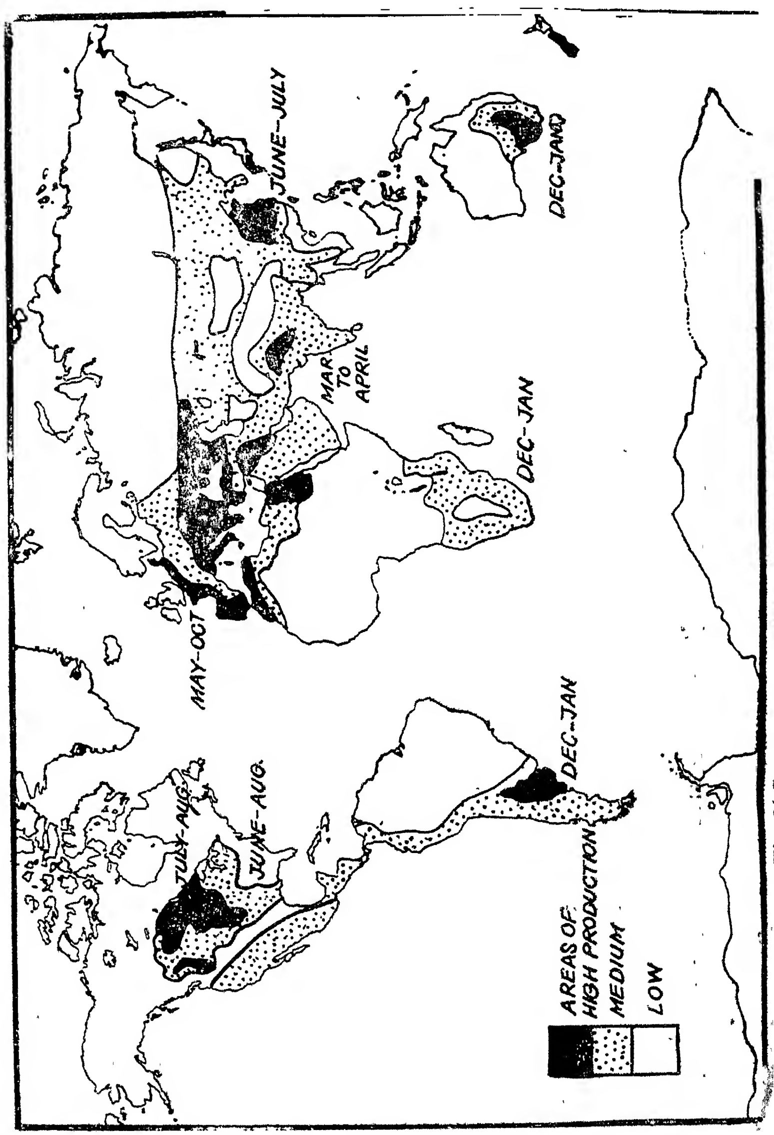


Fig. 21.7 Influence of location upon time of wheat harvest

alone the largest supplies of wheat come from, in India, only for example, it is a winter crop. For it is only then that suitable temperatures are available here. Wheat is sown in India from October to December and is harvested from March to June in different parts. Fig. 21·7 shows the influence of location upon the time of wheat harvest. As winter is a dry over the area where wheat is grown here irrigation plays the most important part in its cultivation in India. In some years when the monsoon rainfall has been insufficient, even sowing of wheat is done with thehelp of irrigation. In Europe and in America, wheat is grown in summer when enough rainfalls. Irrigation is therefore, not an important feature of wheat cultivation in those regions. It is only in Australia, South Africa, and the western part of the United States of America, which are practically deserts, that irrigation is resorted to for this crop.

In south and south east Asian countries wheat is sown only in the loamy soil of the older alluvium. The field in which wheat is intended to be sown usually remains follow during summer when a little manure is also given. Unlike most of the Summer crops, which are sown. broadcast, wheat is carifully sown in the drills made by the plough. The winter rains and the facilities of irrigation in the areas in which what is important are an advantage to wheat in temperate regions of northern hemisphere. as they provide moisture to the plant during its early growth which, accompanied by the cool temperature of December, helps tillering, and a number of stalks shoot the same seed. By the end of February when the grain has formed, temperatures begin to rise and help in the ripening of the crop.

There are certain climatic drawbacks under which Tropical wheat is cultivated. These drawbacks arise particularly about the time of harvest. The change from winter to summer is almost sudden in Tropical wheat belt. The rise of temperature is not gradual in Temperate wheat belt as in Soviet Union or Canada or other wheat-producing temperate countries, and therefore, the crop matures not gradually but quickly. This sudden ripening of the crop leads to the inferiority of the wheat grain in Tropical wheat producing countries. The rise of temperature is usually accompanied by the setting in of very dry winds which quickly dry up the sap in the grain. It is thus not a fully developed well rounded grain as in temperate countries, but a shrivelled up and thin grain. This wind often blows with considerable speed and tends to spoil the crop by felling the plant to the ground, as the indigenous tropical plant has a weak straw. Local storms leading to hail and rain are also common particularly in Northern Plain of India during March and April and cause difficulties in the gathering of the crop. In tropical wheat belt crop ripens in suddenly increasing temperature, while in temperate regions it ripens in gradually falling temperature. The amount of rainfall during the wheat season in Tropical belt clearly indicates the necessity of irrigation. In temperate wheat belt, on the other hand, rainfall is enough for the crop.

Regions with good commercial wheat belts

Although wheat is grown in many climatic regions but most of the important commercial grain farming regions are the Prairie of North America, Canada, Pampas of Argentina, Downs of Australia and Steppe of Soviet Union. The farming of these regions is divided into : (*i*) *Commercial grain farming* just like in U.S A. ; (*ii*) *Commercial and livestock farming* such as in Argentina, Australia. (*iii*) *Commercial crop farming* and *Horticulture*, with subsidiary livestock just like in Europe, Russia and North America. India and Egypt are other important wheat producing regions of the world. Here the method of farming is *intensive irrigation* or *wet farming* just like in some parts of western Uttar Pradesh, Haryana and Panjab, while intensive Dry field farming is also found in many parts of the country. Wet farming and dry field farming methods are also prevalent in Middle East countries. The yield per hectare of wheat in India is very low, owing to the poverty of the Indian cultivator who cannot afford much manuring and shortage of canal water. Even though farming here is intensive, Indian yield ranks with the lower yields of the newer countries of America or Australia where the farming methods are extensive and cannot, therefore, produce high yields per hectare. The yields per hectare in the intensive farming countries of Western Europe are about three times as much as in India. The largest yield per hectare in India is in the western districts of U. P. and Haryana and the lowest in Chhota Nagpur.

It is to be noted that theyield perhectare is law in all the important producers of wheat in the world. The Soviet Union, the United States, Canada, India and Argentina, all record low yields. But the difference between western newly settled countries of U. S. A. or Canada and eastern old settled country India is between extensive and intensive agriculture U. S. A. and Canada generally have extensive agriculture in which less manure is used, and therefore, low yield per hectare results.

WHEAT IN NORTH AMERICA

North America, with its fertile soils, its moderate rainfall, its cool winters and abundant irrigation facilities easily occupied the largest share in world wheat hectarage. The topography of North America is flat, fertile grasslands of the continental interiors that have provided the basis for the doubling of the world's wheat hectarage in the past half-century.

Wheat Region of North America

The wheat areas of North America can be broadly grouped into the following regions according to the productivity and types of wheat.

1. The Spring Wheat Belt

This region comprising Alberta, Saskatwan, Manitoba, Montana, North and South Dakota, Nebraska and Minnesota,

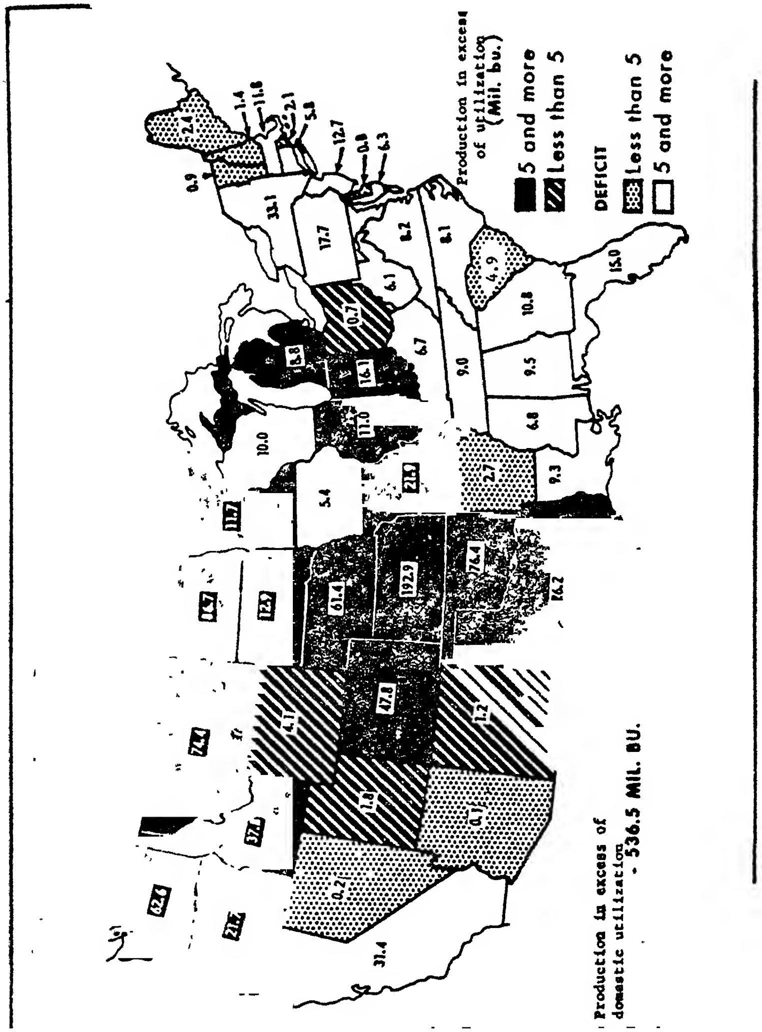


Fig. 21·8. State wise Total Wheat Production.

has only one single spring crop of wheat which can be grown from March—April to September October. Although Spring wheat of red variety is most important but other crops are also grown. The Red valley of Canada and Dakota of U. S. A. are the most productive areas of this wheat belt. Besides wheat, barley, oats, rye, hay etc. are also grown in large scale.

2. Hard Winter Wheat Region

The hard winter wheat belt in western Texas, Oklahoma, Kansas and Nebraska and in eastern Colorado occupies the western portion of the corn and winter wheat climate region and extends well into the regions of temperate grassland climates. About 28% land is under plough. Pad Handle area of Kansas is an important producer. Corn, barley, sorghum, oats and hay are also grown.

3. Soft Winter Wheat Belt

Wheat is grown in almost all the states of this region, as shown in fig 21·8, but its cultivation is mostly concentrated in Indiana, Ohio, Kentucky, Missouri, Pennsylvania, NewYork, Virginia to Southwards upto Gorgia This wheat belt is found in north eastern U. S. A. and extends into the eastern plains of Canada. In Southern states the basic crops, generally grown in rotation, are corn, oats and grass.

4. Columbia Plateau White Region

The cultivation of wheat in North America follows the rainfall line. As one proceeds further into the interior of the continent where rainfall decreases, there is a fall in the cultivation of wheat except in irrigated areas. There are not enough facilities for irrigation of wheat in these regions. This area, which comprises Washington, Oregon, Nevada, western Alberta and Columbia Plateau. Palouse area is most important producer. Fig 21·9 shows the wheat belts of North America.

5. California Wheat Belt

Wheat is grown in almost all the northern regions of California, but its cultivation is mostly concentrated in Sacramento river valley, deltas and low-lying coastal areas of north-western and Southern California. Wheat is mostly of white variety.

WHEAT IN SOVIET UNION

In 1948–53 in Russia wheat hectarage was 426 lakhs and production 60,000 thousand metrictons. Most of wheat area in the U.S.S.R. was found in black earth region. The Ukraine region of Soviet Union is known as bread basket of Russia. Wheat was formerly concentrated on the better black and brown earths, but policy has been to reduce specialization in any one area where crop failure might have serious national consequences. In the older wheat areas, new crops have been introduced ; while a northwards advance has been achieved by developing quick-ripening and frost-resistant strains, which are claimed to grow as far as 60° North. The

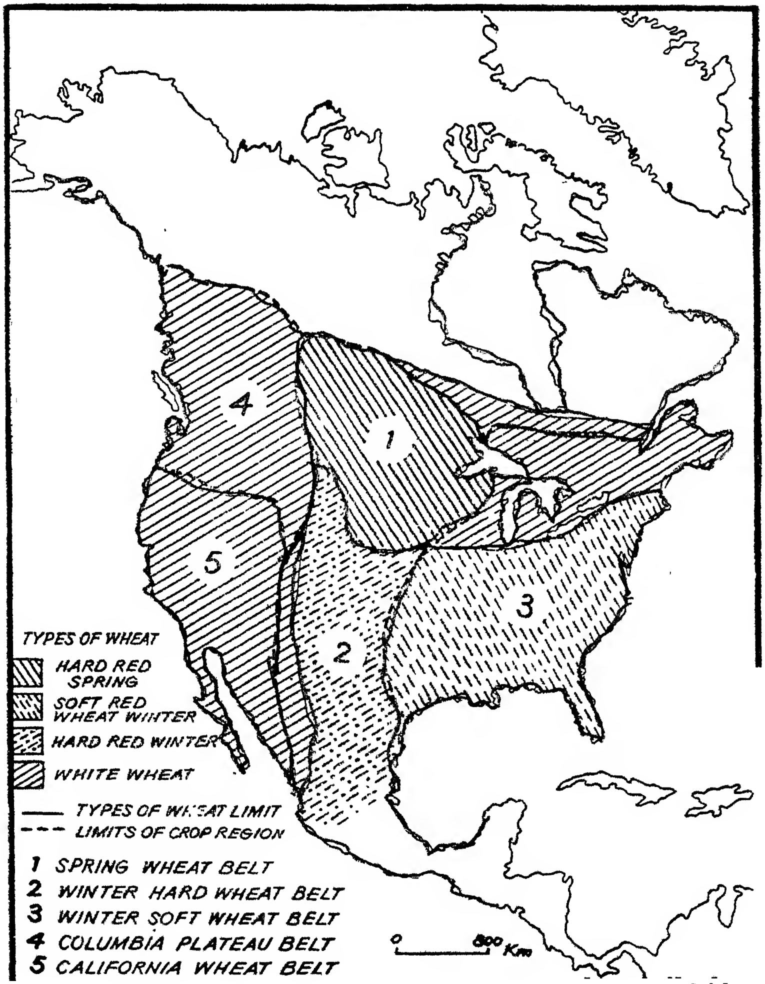


Fig 21 9. Wheat Belt of Notrh America.

wheat areas of the U. S. S. R. can be broadly divided into the following two regions according to the wheat cropping seasons. They are :

1. Winter Wheat Region

Winter wheat, which gives a better yield, is now the most important grain in the Ukraine, Northern Caucasia, and the Crimea. About 18 3 percent land area was under winter wheat in Soviet Union during 1960. Almost entirely winter sown, it remains important in Northern European Russia because of its tolerance to climatic conditions ; though in the intensely hard winters of

Fig. 21 10. Wheat of Russia.

Northern and Eastern Siberia it is spring sown. Fig 21·10 shows the spring and winter wheat belt of Eurasia.

2. Spring Wheat Belt

Like the U.S.A., Russia is a major world producer of spring wheat. It is adaptable to many climatic conditions, providing there is a dry ripening season. Spring wheat is widely grown in

Siberian Lowland, in Kazakhstan, and Baykalia etc. The Soyabeen along with wheat, a recent introduction, comes almost entirely from the Far East, with half the sown area in the Amur district. Animal raising is important occupation. This is one of the most extensively farmed parts of the mixed farming region.

Wheat in China

In 1972–73, China had 28,701 thousand hectares or 13% of the total wheat area of the world. The total output was 34502 thousand metric tons or about 10% of the world output. In fact Soviet Union and China account for about one-half of the area and about 35% of the output of the whole world. Most of the wheat area in China lies in northern China between Kokonor (Tsing Hai) and Honan. More than one half of the wheat area is in Honan, Hupei and Kiangsu provinces of Peoples Republic of China. Wheat become the stable food of N. China.

Like the Soviet Union, the wheat growing areas of China can be divided into two parts, one is winter wheat belt and second is spring wheat belt.

Yellow plain of Northern China is important for growing wheat and wheat becomes the winter crops in Yangtze valley. But in northern China wheat is summer crops due to severe cold and frost.

Spring wheat region is the marginal belt extending east to west and following the Mongolian boarder. About 18% land is under wheat cultivation and rest being hilly and covered by small grasslands.

Wheat in India

The largest hectarage under wheat is found in the drier and higher parts of the Sutlaz-Ganga Plains. Wheat cultivation in India increases from the south to the north, that is to say, on leaving the humid and inundated soils of the south and the east. Wheat is practically absent from the red and yellow soils. The other area without wheat cultivation is the Thar desert or the marshy land of Kutch.

South America

Argentina is important wheat producing country in South America followed by Chile, Uruguay, Paraguay. Parana and Uruguay valleys in South America form one of the most important granaries of the post war period. During 1972 Argentina had 4965 thousand hectares or about 2% of the total wheat area of the world, as shown in Table 21·14.

Table 21·14

Wheat hectarage in selected countries (Figure 1,000 hectares)*

Countries	1969	1970	1971	1972
Algeria	2198	2297	1946	2336
Argentina	5191	3701	4315	4965
Australia	9470	6479	7138	7778
Bulgaria	1040	1014	1013	961
Canada	10101	5052	7854	8640
Chile	743	740	727	712
China	27405	28202	28500	28701
Czechoslovakia	1051	1078	1100	1192
Egypt	531	551	570	523
France	4034	3746	397	3958
W. Germany	1494	1493	1544	1626
Greece	1078	985	979	904
Hungary	1324	1276	1275	1317
India	15958	16626	18241	19139
Iran	5100	5100	5097	5000
Iraq	1661	1759	948	1915
Italy	4218	4138	3910	3821
Japan	287	229	166	144
Morocco	1945	1892	2006	1998
Pakistan	6160	6229	5970	5797
Poland	1965	1985	2061	2048
Portugal	568	602	629	511
Romania	2759	2321	2501	2523
Rep. of S. Africa	1270	1300	1420	1450
Spain	3770	3754	3655	3587
Tunisia	745	1030	950	1122
Turkey	8743	8675	8779	8708
U.S.S.R.	66,426	65,230	64035	58,492
U.K.	833	1010	1097	1127
U.S A.	19079	17629	19 93	19,135
Yugoslavia	2021	1833	1930	1924
World total	220,984	210,422	216455	214673

A study of the geographical distribution of wheat in Australia

reveals that it is grown mostly in the alluvial soils of Murrary and Darling valleys, provided the rainfall is less than 30 cm. Farming is mostly down by machinery.

Wheat is also grown in France, Northern Italy, Danube lands, Poland and Spain. In United Kingdom wheat is grown in Loess soil of York, Lincone etc.

Production of Wheat

The world hectarage of wheat during the year 1972 was reported to be 214,673 thousand hectares as against 216,455 thousand hectares in 1971. Production of wheat in the same year was 347,621 and 353,899 thousand tons. Within the wheat map of the world the U.S.S.R. stands out predominantly in production followed by the United States, Peoples Republic of China, India, France, Turkey, Canada, Italy, as seen from table 21·15.

Table 21·15

Wheat Production in selected countries
(Figs. in 1000 metric tons)

Countries	1969	1970	1971	1972
Algeria	1326	1435	1235	1956
Argentina	7020	4920	5680	7900
Australia	10,546	7889	8510	6551
Bulgaria	2,569	3032	3095	3582
Canada	18268	9024	14,412	14,514
Chile	1214	1307	,368	1,195
China	28,510	31004	32,502	34502
Czechoslovakia	3257	3174	3,878	4017
Egypt	1277	1519	1,732	1618
France	14,459	12,921	15,482	18123
W. Germany	6,000	5662	7,142	6608
Greece	1724	1930	1,906	1919
Hungary	3585	2723	3,922	4095
India	18,652	20,093	23,833	26,410
Iran	4,200	4262	3700	4500
Iraq	1183	1236	822	2625
Italy	9585	9689	9475	9423
Japan	759	475	440	284
Morocco	1594	1801	2188	2161
Paskistan	6617	7294	6588	6890
Poland	4710	4608	5455	5147
Portugal	454	548	794	612
Romania	4349	3356	5595	6041
Rep. of S. Africa	1328	1238	1670	1746

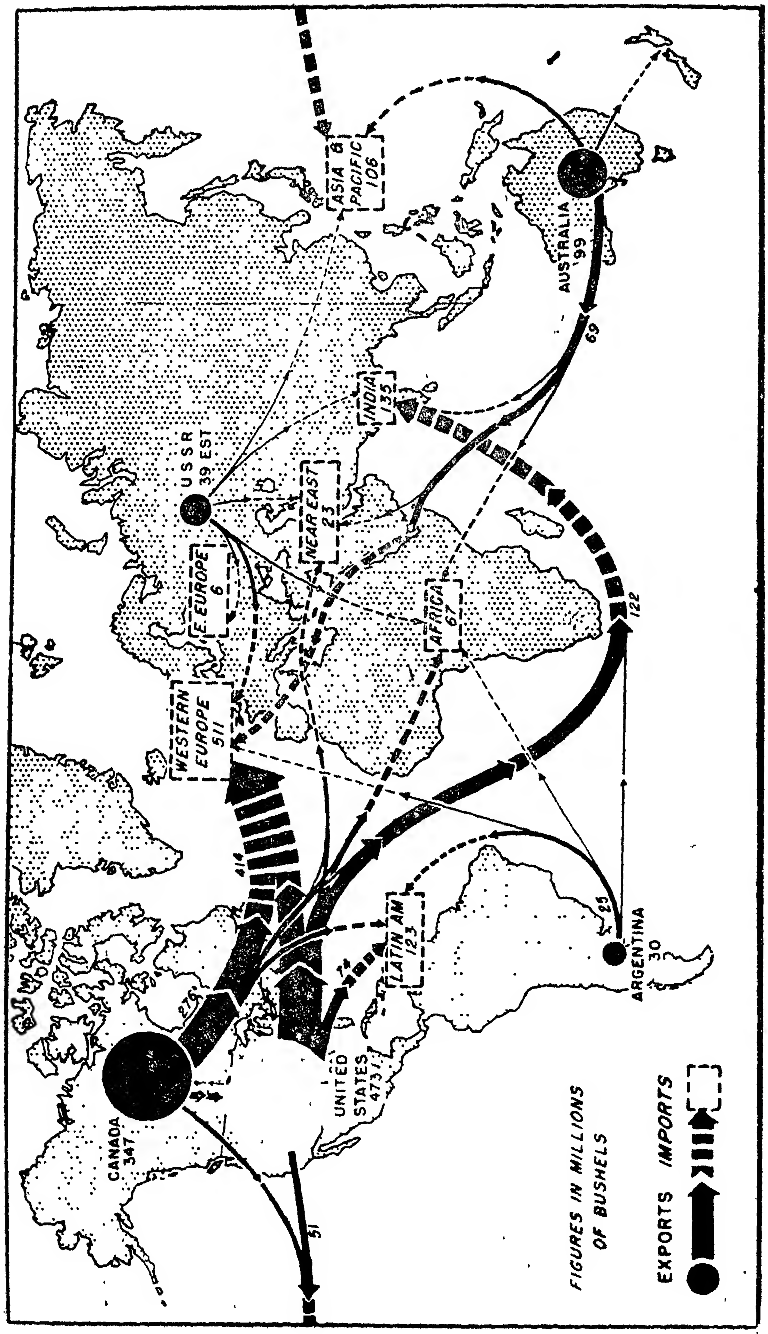


Fig. 21·11. International Trade of Wheat. (on average basis)

Spain	4626	4060	5456	4562
Tunisia	336	449	600	914
Turkey	10,593	10,081	13594	12,275
U.S.S.R.	79,917	99,734	98,760	85950
U.K.	3,364	4,236	4815	4780
U.S.A.	39,264	36,784	44030	42045
Yugoslavia	4,882	37 2	5605	4843
World Total	3,4,757	318,302	353899	347621

Trade of Wheat

The largest producers of wheat in the world are Russia, followed by U.S.A., China, India, France, Canada and Turkey. India normally stood fourth among the world producers of wheat. Fig. 21·11 shows most of the world's export wheat has come from the United States and Canada, Australia and Argentina and the U.S.S.R. According to Smith, Phillips and Smith "Canada, Australia, and Argentina are predominantly agrarian and pastoral countries with relatively small populations and generally export between 50 percent and 60 percent of their wheat crop." The United States although industrially advanced and her north eastern industrial region is wheat deficit area, even then U.S.A. is a major exporting country of the world. Most of the exports went to Latin and Central American countries, South and South East Asian countries and Africa. Table 21·16 shows the trade of wheat in the world.

Table 21·16

Trade of wheat and wheat flour[1] (in lakh metric tons)

	1971–72	1971–73	1973–74	1974–75
World Exports	521	676	631	644
U.S.A.	177	320	313	299
Canada	114	156	117	110
Australia	85	56	55	84
E.C.M.	50	65	53	70
Soviet Union	61	13	50	40
Argentia	17	35	11	22
World Imports	515	676	631	644
To U.S.S.R. & Europe	175	272	169	128
To North & Central America	19	23	26	26
S. America	44	62	65	52
Middle East	31	26	40	65
Far East	184	218	240	280
Africa	59	67	85	88
Others	3	8	6	5

1. UN Eco Comm. for Europe, African Market Rev. No. 17, 1975.

MAIZE

Maize after wheat and rice, is the third largest food crop of all over the world. It prefers fertile soil, especially loam and is, therefore, grown mostly in North American Plain, Para and Uruguay river valleys, Hwang Ho, Indus Ganga and Brahamputra Plain. Majority of the crop is grown with the first summer rains and is reaped almost as soon as the rains stop. For optimum growth of plant, corn needs a plentiful supply of moisture well distributed throughout the growing season, maximum yields in the world being obtained where there is a mostly rainfall of 25 to 45 cms. during June to September.

Climate of Tropical region does not favour the cultivation of maize to any large extent. Very high temperatures during the growing season are the main obstacle. It will be seen that the region of the greatest production of maize is the United States of America, which produces the bulk of the world's supply of maize, has a mean summer temperature of 14°C to 16°C. In tropical countries, on the other hand, we notice that the average is more than 19°C during the period maize is grown here. This unfavourable climate is mainly responsible for the low yield per hectare in tropical region in comparison to the United States.

Important Corn Belts

Although the growing of corn is very widely distributed but the six major zones of production may be recognized : (1) the United States corn or maize belt, (2) the Pampas of Argentina, (3) the Danubian countries, (4) the Mediterranean countries, (5) the highlands of tropical America, (6) Southeastern Asia, especially China, India and Java etc.

The United States Corn Belt

In United States maize is grown from the Gulf of Mexico to the Great Lakes, from the Atlantic ocean to eastern Colorado, and in scattered areas beyond. Maize is grown in almost all the states of this belt, but its cultivation is mostly concentrated in Ohio, Indiana, Illinois, Iowa, and Central Nebraska and from southern Illinois to Southern Wisconsin and Minnesota, which together contribute about 50 to 60 percent of the worlds output. In the southern cotton belt, maize is also important crop but total hectarage remains far below that of cotton and yields are low. About 80 percent of American maize is fed to animals, much of it on the farms where it is grown, and sold in the more condensed form of cattle, hogs, poultry, sheep or their products.

Corn in Argentina

In 1972, Argentina maize hectarage was 3147 thousand and production during the same period was 5860 thousand metric tons. Most of the corn area in Argentina is situated in lower Parana river in the humid Pampa. Not only in area, but in production also Argentina raked second in South America, followed by Brazil. Fig 21·12 shows the maize producing countries.

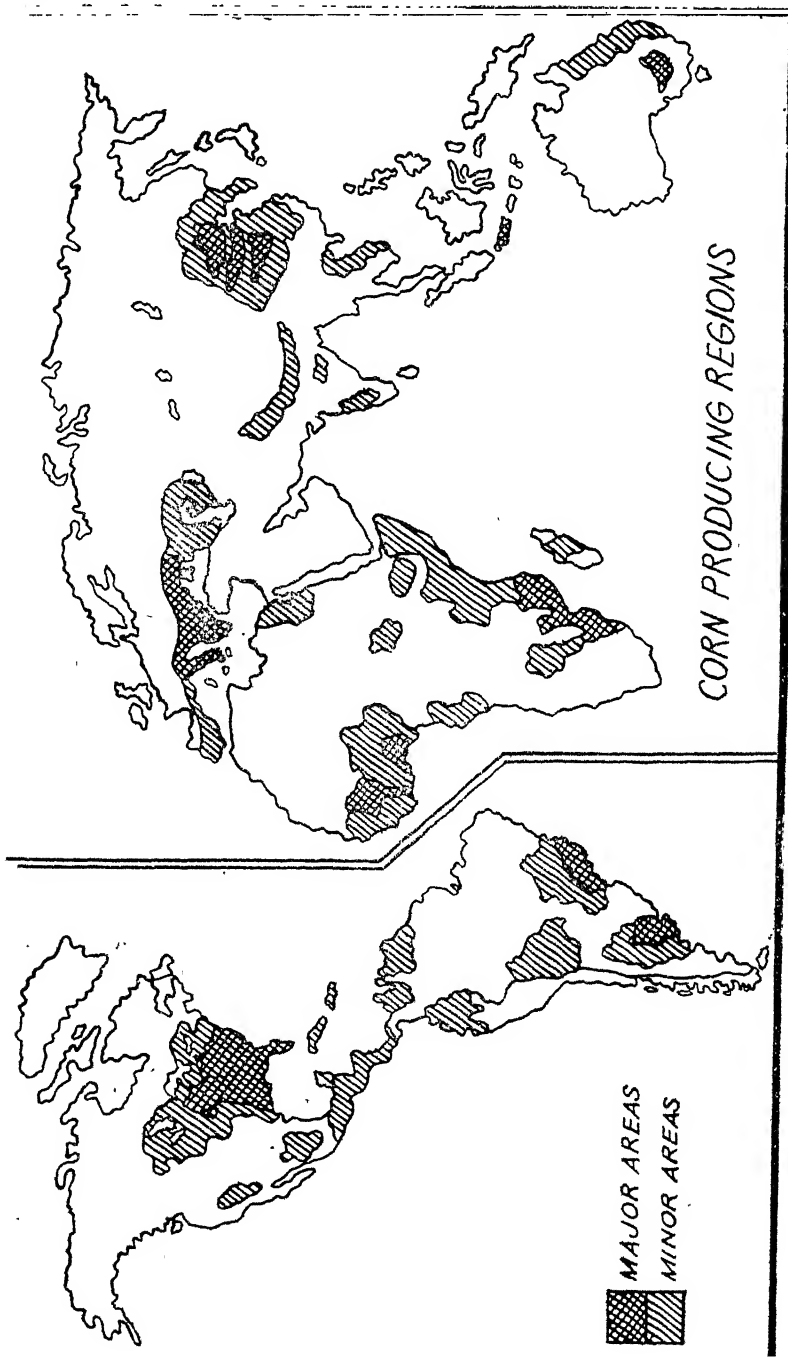


Fig. 21 12. Maize Producing Region

Highlands of Tropical America

During 1961–65 in Brazil maize area was 2836 thousand hectares and maize production was recorded 4984 thousand metric tons for the same period. Three-fourths of the crop is grown in the states of Minas Gerais, Sao Paulo and Rio Grande do Soul. Corn is grown in Colombia, Venezuela and other highlands of Tropical America. Corn is the mean diet of native Indians.

Mediterranean and Adjacent Regions

The six countries, Romania, Bulgaria, Greece Albania, Yugoslavia and Italy accounted for about one-fourth of the total maize area of the world. Not only in area, but in maize output also Romania ranked first in Mediterranean and adjacent regions. About 3197 thousand hectares or 3 percent of the total hectarages are under maize crop in Romaina. The plains of northern Portugal and northwestern Spain near the ocean have rainfall sufficient for mediocre growth of corn without irrigation, the combined output of these two countries being about equal to the crop of Egypt. In 1961–65, Egypt had 646 thousand hectares under maize crop in Africa. The total output was for the same period was 1913 thousand metric tons.

Corn in Danubean Lands

The Denubean lands and adjacent regions to it, from Southern Germany to Romania are the most maize area of Europe. But the region of greatest production is the Hungarian plain, which reaches from Dunavska to Slovakia and from Savska to East of Transylvania. This region is one of the best agricultural sections of the Europe. In Hungary, during 1972 corn hectarage was 1396 thousand and production was 5554 thousand metric tons. While in area Bulgaria stood least in European countries but its yield per hectare is comparatively highest. In 1961–65 Bulgaria had 632 thousand hectares and the total output for the same period was 1601 thousand metric tons.

The maize belt of Romania and Hungary also extends Eastward into the regions of temperate grassland climates of Soviet Union. Although a lover of heat, maize does not do its best in the tropics. Maize in Soviet Union, has been introduced into the newly ploughed regions and is grown in the south eastern foothills of Kazakhstan, but the main centres are the Southern Ukraine and Northern Caucasia as well as Moldavia and the central black earth belt, where it is primarily a grain crop. In the north, where grain will not ripen, it is for fodder and silage.

Maize in South and South Eastern Asia

This area, which comprises Sri Lanka India, Pakistan, Bengla desh, Burma, Thailand, Combodia, Vietnam and Indonesia, where majority of the crop is grown with the first summer rains and is adversely affected by the rain if come late and the crop is damaged, or if there are very long intervals between therainy periods. The

cultivation of maize is characterised by interculture, that is, several things are sown mixed. Among the seeds sown thus, are sevesal vegetables, like pumkins and cucumbers, various kinds of pulses like *Mung* and *Arhar* and some oilseeds like sesame. *Arhar* takes full winter to mature and is harvested separately with the rabi crops.

This interculture has an important and scientific place in the agricultural practice in monsoon Asia. Some of the crops like the *arhar* have deep tap roots on which form the bacteria which enrich the soil Interculture has thus its agricultural value. The vegetable crops mature quickly and provide food to the poor agriculturist at a time when his stock of food is at the lowest.

China is th[illegible] largest producer of maize after the United States [illegible]ize, is little grown in the east and south,where r[illegible] are more profitable, but it occupies 20 percent or [illegible] of the cropland in many districts west of a line from the Hwang-Ho mouth to eastern Yunnan. India is important maize producing nation.

Hectarage and Production

The average area under maize of the world during 1961–65 was 99,717 thousand hectares. The highest hectarage was recorded in 1971 when it reached a peak of 111,425 thousand hectares. The largest area under maize in the United States during 1972 was 23,237 thousand hectares ; that is 21·9% of the total maize area of the world. The second highest percentage of maize area is in Brazil, about 9·9 percent followed by China 9 8%, Mexico 6·3%, India 5 4% and South Africa 5·0%. Table 21·17 shows the area under maize in selected countries.

Table 21·17
Area Under Maize crop Area (1,000 hectares)

Countries	1969	1970	1971	1972
Argentina	3,556	4,017	4,066	3,147
Brazil	9,654	9,858	10,550	10,539
Bulgaria	574	635	655	689
China	10,119	10,523	10,619	10,523
Colombia	800	706	804	796
Egypt	626	633	641	646
France	1,185	1,486	1,645	1,880
Ghana	275	400	344	311
Greece	149	170	166	163
Hungary	1,273	1,206	1,337	1,396
India	5,862	5,852	5,668	5,7.6
Indonesia	2,435	2,939	2,616	2,216
Italy	999	10,419	934	892

Mexico	6,872	7,419	7,135	7,026
Morocco	465	510	453	481
Pakistan	648	640	633	645
Peru	364	382	374	301
Philippines	2,420	2,396	2,432	2,622
Portugal	427	418	393	390
Rhodesia	410	350	450	520
Romania	3,293	3,084	3,131	3,197
Rep. of South Africa	5,120	5,200	5,550	5,650
Spain	494	530	557	534
Turkey	659	648	6[illegible]	601
U.S S.R.	4,167	3,353	3,332	[illegible],012
U.S.A.	22,085	23,212	25,919	23,237
Venezuela	641	588	588	564
Yugoslavia	2,399	2,352	2,425	2,383
World	104,417	107,072	111,425	108,58[illegible]

The world hectarage of corn during the year 1972 was reported to be 108,584 thousand as against 107,072 thousand hectares in 1970, Production of maize in the same year was 304,354 and 261,149 thousand metric tons. The United States was recorded the highest production in 1972 and stood first with 46 percent of world's total, followed by China 6%, Brazil 4%, U S.S.R., Romania, South African Republic and Mexico 3% each and France and India 2% each, is evident from table 21·18.

Table 21·18

Production of maize in selected countries
(Figures in thousand metric tons)*

Countries	1969	1970	1971	1972
Argentina	6,860	9,360	9,930	5,860
Brazil	12,693	14,216	14,130	14,891
Bulgaria	2,415	2,375	2,518	2,974
China	27,245	29,057	30,053	28,560
Colombia	920	862	915	955
Egypt	2,368	2,397	2,342	2,421
France	5,726	7,592	8,970	8,190
Ghana	304	442	384	389
Greece	409	510	549	579
Hungary	4,820	4,073	4,732	5,554
India	5,674	7,485	5,101	6,206

The Statesmans Year Book 1974–75.

Indonesia	2,293	2,825	2,636	2,269
Italy	4,519	4,754	4,528	4,802
Mexico	8,208	9,041	9,302	9,401
Morocco	450	321	390	368
Pakistan	668	717	705	706
Peru	585	615	616	589
Philippines	2,008	2,007	2,013	2,117
Portugal	553	581	526	519
Rhodesia	1,020	700	1,179	1,540
Rep. of S. Africa	5,339	6,423	8600	9,630
Romania	1,020	700	1,179	1,540
Spain	1,000	1,8 0	2,035	1,920
Turkey	1,500	1,006	1,100	1,030
U.S.S.R.	11,954	9,428	8,597	9,833
U.S.A.	119,056	105,463	143,290	141,568
Venezuela	670	710	713	567
Yugoslavia	7,821	6,933	7,442	7,940
World total	265,181	261,149	304,978	304,354

Trade of maize

The crop is raised mainly in monsoon and others developing countries for consumption and hence exports are inconsiderable. The use of maize for human consumption is also more prevalent in Mediterranean countries than in Northern states of the United States. Southern states are also used but much less quantities than Mediterranean countries of Europe. In recent years industrial firms have developed the production of starch and glucose from maize. About 80% of American corn is fed to animals. In recent years the maize belt of North America has become a major producer of beef cattle as well as a cattle fattening region. All the nations of western hemisphere, with the sole exception of Peru, are exporters of maize, most of which now comes from the United States and the pastoral countries of the south temperate zone such as Argentina.

BARLEY AND GRAM

Barley and gram are two winter grain crops in Tropical countries which rank along with wheat as staple foodgrains in developing monsoon and African countries. Barley is mixed crop in Tropical countries but best thrived in temperate countries as shown in fig. 21·12. In the higher elevations, all over the world wheat gradually gives way to barley. Sometimes both are grown in combination. In Tropical countries barley and gram are mixed crops. But the barley matures earlier and the harvesting therefore begins about 15 to 20 days earlier than wheat. In tropical countries the important matters of elevation, aspect and shade, are by no means determined, nor are they attended to as they ought to be. In temperate countries a suitable elevation, would seem to have much

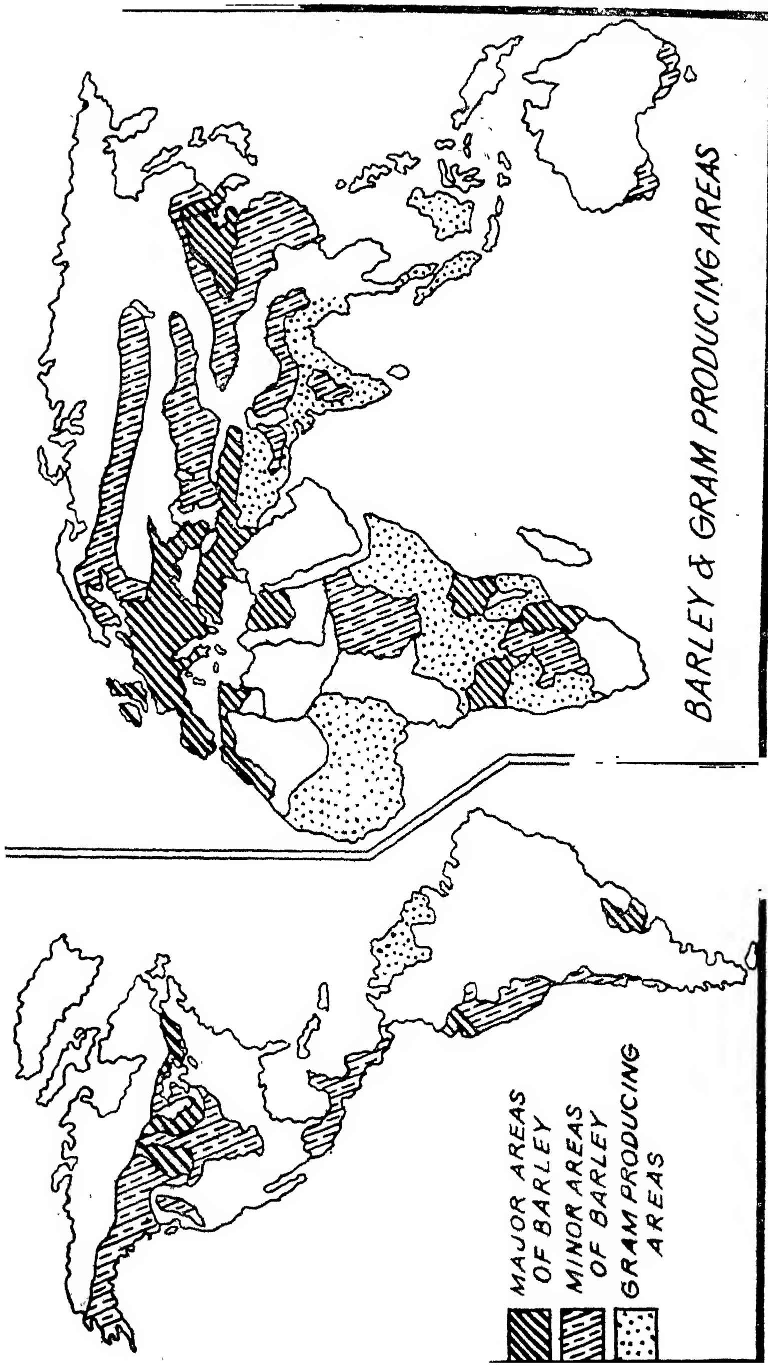


Fig. 21·12. Barley and Gram Producing Areas.

to do with the successful cultivation, though along with it must be taken the consideration of rainfall. The kind of soil, or rather, its earlier history, is a point of the highest importance. If the land has previously been old forest land, thinned for the purpose of growing barley, it is likely to do well, but if it be that which has before been under cultivation, it is not nearly so valuable.

The aspect must be studied, chiefly in the matter of shade, while both the presence of shade and the kind or amount of shade provided are most essential points, in barley cultivation. Perhaps nothing affecting the cultivation of barley impressed me more than the importance of shade I have been over some regions of Himalaya, where shade has been attended to, and I have noticed the healthy and natural growth of the barley. I have also been to other places in southern and eastern India where shade has been neglected and dependence has been placed upon heavy manuring. I have little doubt that the failure of many barley in other parts of India is due to the clearing away of the trees, and the neglect to provide other shade. It is grown at the same season as wheat and generally in the same way, but with less lobour and expense. Thus it gets fewer ploughings, less manure, less water or being much more frequently grow without irrigation.

Production and Area

Production is largely confined to the northern hemisphere throughout which barley are grown. It is particularly intensive in the Union of Soviet Socialistic Republic, Canada, France, U.K., U.S.A. and parts of Mediterranean countries. Barley form a fodder crop principally in central and eastern states of Europe, while barley in Russia, sown further north, is cultivated in Karelia and in the lower reaches of the Ob and Yenisey, its lower moisture needs also allow its substitution for oats in drier areas. The sown area has remained fairly constant, with few exception, but spring barley has declined and is grown in the Black sea littoral, Northern Caucasia, and in the Central Asian foothills where it can mature before the hot season.

In Canada, long duration varieties still account for much of the crop, but short duration varieties are being grown to an increasing extent.

In northern China and Manchuria, barley occupies second place to wheat as a winter crops. The Yangtze delta is the leading area in production. Barley is widely grown in the north and north-western India, Paksitan and upto Turkey. It is eaten as a cheap grain, fed to cattle, or made into wine or beer. Stalks serve as animal fodder.

Canada is the second largest producer of barley after the Soviet Union. Barley is grown upto 60° north latitude, where wheat or corn are negligible. The out turn of grain is rather higher than in the case of wheat, while in tropical areas a large proportion of this is the husk. Table 21·19 shows the hectarage and production of barley in selected countries of the world.

Table 21·19
Production and area of barley in selected countries

Countries	Area in thousand hectares			Production in thousand metric tons		
	1970	1971	1972	1970	1971	1972
Algeria	855	651	781	571	340	720
Argentina	356	479	601	367	553	880
Australia	2000	2535	2185	2352	3065	1780
Bulgaria	403	434	445	1167	1253	1427
Canada	4040	5654	5063	8889	13099	11287
Czechoslovakia	801	848	850	2280	2851	2651
Denmark	1352	1370	140[illegible]	4813	5458	5572
France	2953	2671	2674	8126	8910	10426
Germany, East	640	656	618	1926	2286	2592
W. Germany	1475	1505	1549	4754	5774	5997
Hungary	284	299	292	553	785	807
India	2765	2555	2456	2716	2784	2577
Iran	1385	1238	1250	1083	900	1009
Iraq	673	396	726	682	432	980
Japan	226	164	121	572	503	325
S. Korea	904	832	850	1974	1858	1965
Mexico	253	255	251	284	306	294
Morocco	1890	2023	1957	1953	2572	2466
Peru	186	183	182	170	159	170
Poland	924	899	1017	2149	2450	2750
Romania	288	330	327	513	789	839
Spain	2220	2371	2519	3092	4783	4358
Syria	1126	436	593	235	123	710
Tunisia	410	350	358	151	140	236
Turkey	2575	2571	2503	3250	4170	3725
U. S. S. R.	21297	21566	27269	38172	34571	36811
U. K.	2243	2288	2288	7529	8558	9244
U. S. A.	3936	4109	3929	9061	10095	9221
Yugoslavia	280	280	290	402	464	487
World	78088	79590	84745	139450	15,473	152673

Trade of Barley

The international trade in barely is small, amounting to about 7 percent of the annual output. Germany and the United Kingdom are the leading importers, being amongst the greatest b er drinkers,

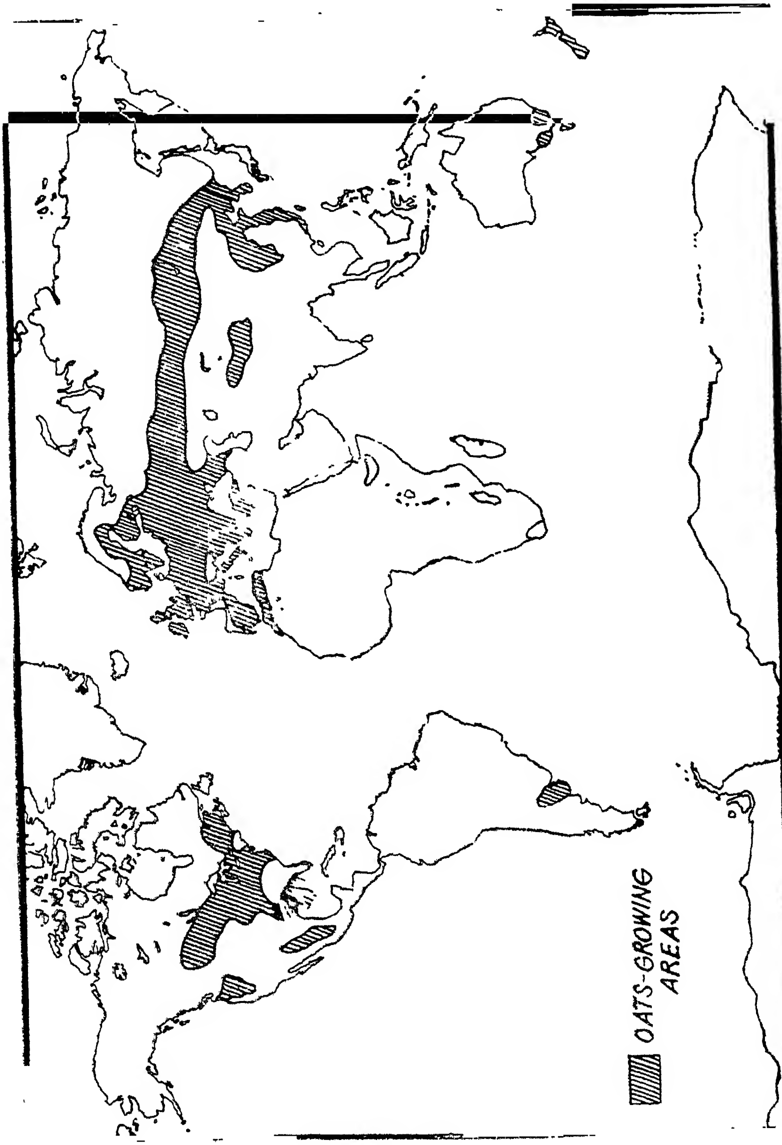


Fig 21·13 Oats Areas of the world.

and the U. S. S. R., Romania, Hungary, the U. S. A. and Canada are the major expoters.

OATS

Oats grain grows best in a cool, humid climate in the temperate zone and is less resistant to cold or heat than either wheat or barley. It is thus not found in the Tropical and Sub Tropical lands of South America, Asia and Africa where the climate is both damp and hot. Oats are also grown in a broder range of soils than either wheat or barley.

Oats is generally a spring-sown crop and grown in rotation with winter wheat or rye.

Areas of Production

The areas of heaviest oats production lie northward of the major wheat areas in Eurasia and north and east of the wheat belts of North America which is shown in fig. 21·13. Oats is mostly grown in Scotland, Wales, Norway, Sweden, Canada and Newfoundland, where the climate is too harse for wheat to mature. Small quantities of oats is also grown in the temperate regions of three southern continents. The largest oat growing areas are U. S. S. R. followed by U. S. A., Canada, China, Netherlands, Australia and France as shown in table 21·20.

Table 21·20

Oats Area and Production*

Countries	Area in thousand hectares 1972	Production thousand metric tons 1972
Argentina	399	566
Australia	1007	752
Austria	96	255
Belgium	67	249
Canada	2470	4630
China	2600	2500
Czechoslovakia	318	726
Denmark	163	637
Finland	501	1245
France	762	2464
Germany, East	247	775
Germany, West	808	2877
Hungary	52	64
Irish Republic	54	180

* The Statesmans Year Book 1974–75.

Italy	262	461
Netherlands	33	140
Poland	1359	3212
Portugal	168	85
Romania	121	111
Spain	467	440
Sweden	503	1630
Turkey	293	396
U. S. S. R.	11358	14081
U. K.	314	1250
U. S. A.	5474	10044
World Total	**31215**	**51316**

The international trade in oats is small, amounting to not more than 2% of the annual production, U. S. S. R., Canada, Argentina and Australia are the major exporters.

RYE

Rye ranks next to wheat as a bread grain of northern temperate regions of Eurasia and North America and Greenland because of its high gluten content. Rye is most adaptable corp to every type of soils It also tolerates excessive moisture better than wheat and is very resistant to pests and diseases.

Area and Production

U.S.S.R. the outstanding producer, grows over 35 percent of the world's annual rye out put of 9230 thousand metric tons. In Soviet Russia, rye traditional forest belt cereal and making a whole some but less nourishing bread than wheat, has fallen from 10,020 thousand hectares in 1970 to 9507 thousand hectares in 1971 under the pressure of wheat growing. Almost entirely winter sown, it remains important in Northern European Russia because of its tolerance to climatic conditions; so it is grown beyond the Arctic circle in Europe, Russia and North America, the main area of production extends 480 kilometres north of the winter wheat belt, as shown in fig 21·14. In Eastern Siberia rye is spring sown crop.

Poland and west Germany, with 23 percent and 9 percent respectively are major producers. Other producers are East Germany, followed by Turkey, Argentina, Czechoslovakia, U.S.A. and Austria. Table 21·21 shows the production and area under rye in selected countries.

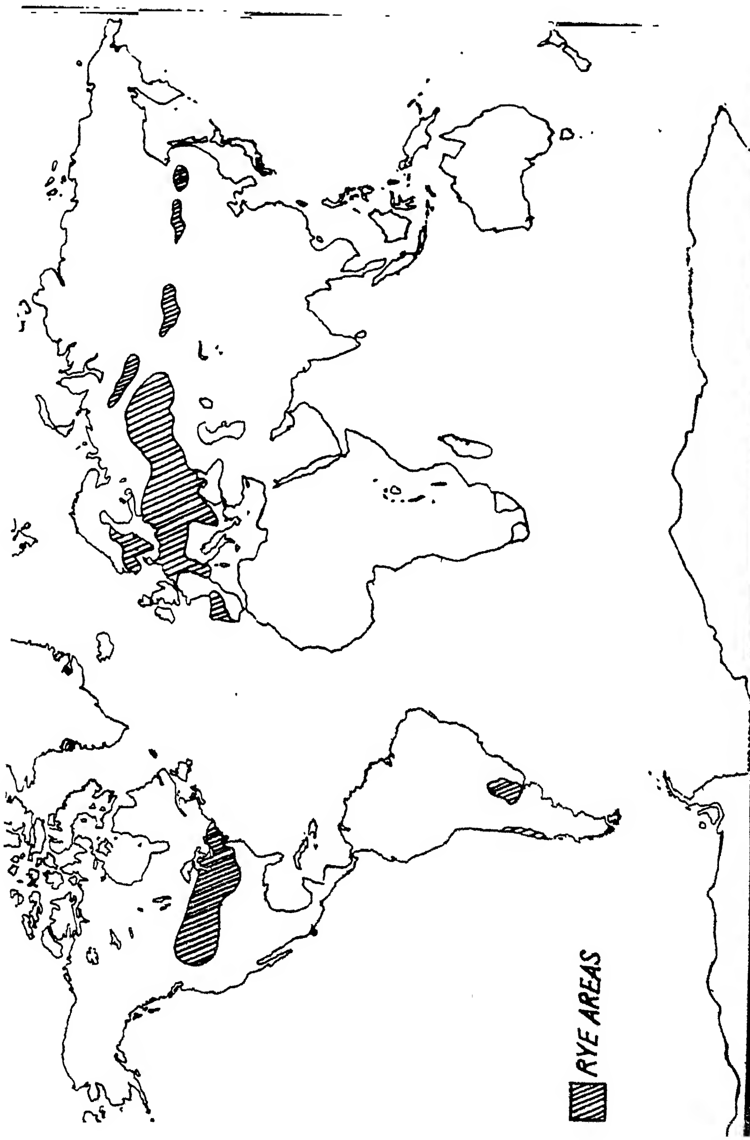


Fig 21·14. Imoprtant Rye Producing Regions

Table 21·21

Area and Production of rye in selected countries (Fig. in thousand hectares and thousand metric tions)*

Countries	Area 1970	1971	1972	Production 1970	1971	1972
Argentina	360	433	747	181	256	690
Austria	136	145	144	363	448	402
Belgium	21	25	21	65	89	76
Bulgaria	22	19	17	28	24	21
Canada	336	387	257	480	557	344
Czechoslovakia	219	234	232	454	619	634
Denmark	44	42	42	135	150	155
Finland	66	66	59	131	132	119
France	135	128	128	287	294	331
Germany, East	680	668	646	1483	1754	1904
Germany, W.	864	864	842	2663	3082	2914
Hungary	152	128	121	158	182	173
Italy	35	29	25	69	55	50
Netherlands	57	60	54	172	209	151
Poland	3413	3711	3543	5433	7827	8149
Portugal	233	231	226	157	168	164
Romania	45	48	42	43	65	58
Spain	313	292	278	258	265	263
Sweden	80	83	107	228	305	366
Turkey	650	655	625	630	895	755
U.S.S R.	10020	9507	8160	12972	12787	9630
U.S.A.	577	710	439	936	1252	741
Yugoslavia	112	110	104	127	134	120
World	18732	18733	17025	27634	31693	28,403

There is very little trade in rye as it is a crop grown almost exclusively for home consumption.

MILLET

Millets are grown in tropical and sub-tropical areas with low and seasonal rainfall. They are grown in all those areas where the soil is rather infertile owing to its rocky or sandy character. The largest hectarage under them occurs in India, Nigeria, the U.S.S.R., Ghana and Uganda. The least hectarage is in Japan as shown in table 21·22.

* F.A.O. Publications and Stteasmans Year book 1974–75.

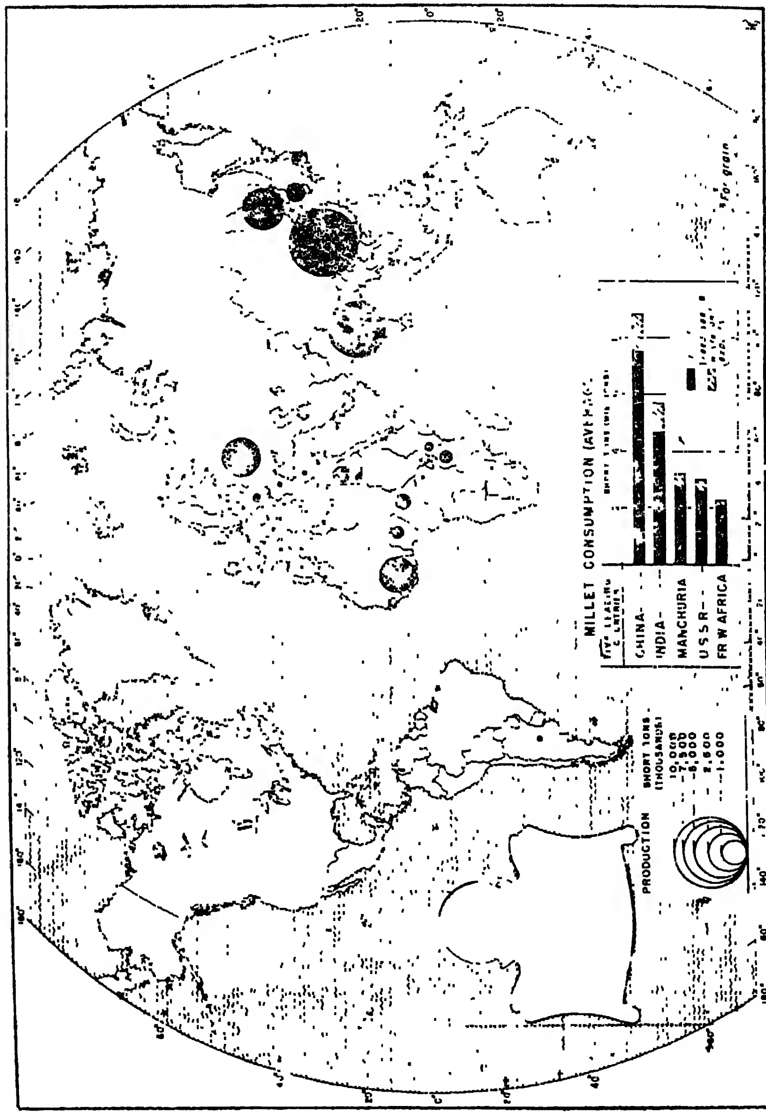


Fig. 21·15. Millet Production and Consumption

Table 21·22
Area and Production of Millets*

Countries	Area in thousand hectares 1971	Area in thousand hectares 1972	Production in thousand metric tons 1971	Production in thousand metric tons 1972
Argentia	151	116	183	105
Australia	49	35	58	38
Cameroum	476	500	331	320
Chand	965	927	631	366
Egypt	208	203	854	831
Ghana	230	175	122	98
India	18675	18178	9197	7183
Japan	6	7	10	12
S. Korea	43	40	35	31
Mali	1300	1200	900	600
Niger	1470	1470	610	580
Nigeria	4783	4839	2688	3048
Pakistan	759	612	380	304
Poland	18	15	23	18
Rhodesia	390	390	220	220
Senegal	975	950	583	430
Sri Lanka	22	23	13	16
Sudan	560	600	325	353
Syria	25	34	19	27
Togo	300	300	130	130
Turkey	41	38	61	52
Uganda	580	580	630	630
U.S.S.R.	2397	2724	2043	2123
Upper Volta	728	653	277	258
Zaire	40	40	38	30
World total	68176	66786	45480	41851

In India several varieties are grown. These grains cover a larger hectarage than any other grain in India, except rice. The main types are the *Jawar*, *bajra*, chari etc Jawar or the great millet prefers wetter and more clayey soil, while the smaller grain or *bajra* grows well in drier and sandier soil. In tropical countries the millets are the chief rainy grain crop in all the areas where rice is grown. Their importance lies not only in the fact that they are a staple food for a very large section of the people of the peninsular India throughout the year and in northern Indian during winter,

* Op cit, 1974–75.

but also in the fact that they provide a substantial part of the fodder supply of India. The fodder value of the *Jawar* plant is so great that in some parts of U.P., Hariyana and Panjab the crop is raised even by irrigation solely for that purpose.

Kaoliang is grown in northen China and Manchuria which is grown both for food and forage. *Durra* a Guinea corn a food crop in Tropical lands which is usually grown in Chand, Mali, Senegal, Uganda and Latin American countries. There is practically no trade of millets.

CHAPTER 22

BEVERAGE CROPS

Several beverage crops are grown on a large scale in Tropical lands, chief among these are tea, coffee, cocoa etc. They are of considerable economic importance to the country, providing raw material for internal consumption and serving as valuable sources for earning foreign exchange.

TEA

The premier beverage crop is tea grown exclusively in the Tropical and sub-Tropical zones, but consumed in all parts of the world.

Geographical Conditions

Tea is grown in a wide range of physical and climatic environments, but it grows best in the monsoon lands of Asia. The ideal climate for the cultivation of tea is the one where the daily variation of temperature is from 22°C to 28°C. If the atmosphere is very moist, this variation may be a little greater. A rainfall of about 130 cms annually, if it is well distributed throughout the year, is enough. Nothing is more injurious to tea crop than long dry preiods.

A soft and well-drained soil is the best for this crop. Light sandy and deep loams are much preferred. Apart from the production of leaves on the tea-bush, the flavour of tea depends largely on the chemical constituents of the soil. Relatively large quantities of phospherous and potash in the soil account for the special flavours of the tea produced in India. The soils in which tea is grown in the Himalayan slopes vary considerably, but the best is a light, rich soil containing a good deal of humus mixed with sand.

The tea shrubs grow on well drained lands as stagnant water is harmful to the plant, so that hill slopes are particularly preferred, though if the drainage is good, it grows equally well in valleys.

Methods of tea cultivation

The tea plants are raised from seeds and not from cuttings. The plants, reserved for seed production, are not used for gathering the leaves. but are allowed to grow to a height of 3 metres to 6 metres. The seeds are sown in nurseries and seedlings, when about six months old, are then planted in fields which have been specially prepared before-hand.

The sowing of seeds starts in October and November and continues up to March The seedlings are transplanted when the rains begin. During dry periods after transplantation irrigation has to be provided to help the plants to grow up. The plant is

ready for plucking in three years. The season for gathering leaves commences about the beginning of April and continues until October. There are generally these gathering from each plant every season. The first is some time from April to June, the second from July to August and the third from September to October. The number of gatherings, however, depends entirely on the nature of the season. If rain falls in winter and in spring, as many as five gatherings may be obtained.

Pruning of the plant is an essential part of tea cultivation. It is done annually during the period when the plant growth has stopped. In India the period of pruning is generally from December to March. The main of pruning is to have new shoots bearing, soft leaves in plenty. It also keeps the tea bush low enough to facilitate the plucking of leaves from the ground.

In order to help the plant to grow plenty of leaves, considerable attention is paid by the tea planter to maintain it in good health. Frequent tilling of the soil to eradicate weeds, and the use of several kinds of manures is generally practised The most common manures in India are the oilcakes. Recently, green manuring has also been practised. In Sri Lanka, large quantities of chemical manures, like sulphate of potash are used.

Tea-picking is usually done by women who are better pickers and can be employed relatively cheaply. In China there are only three pickings in a year. In China there are only three pickings in a year. In India and Sri Lanka, picking is much more frequent.

Tea Growing Regions

The growing of tea is confined in China, India, Japan Sri Lanka, Indone ia, Kenya, Uganda etc. as shown in fig. 22·1.

China

China was for centuries the greatest producer, consumer and perhaps trader in tea. Tea bushes are raised on the hill sides of all the south China provinces, especially in areas midway between the Yangtze and the Si Rivers. Hunan, Kiangsi, Anhwei and Fukien are major producers. Both green and black teas may be produced from the same bush, depending on methods of curing.

Japan

Tea is widely raised in Japan. Tea gardens are small, not more than ·4 hectare in extent and yield mostly green tea. The greatest concentration is on the eastern slopes of the Japanese Alps in southern Honshu, especially in Shizuoka prefecture, which accounts for halp of Japan's tea output. The soil is only moderately fertile, but intensive cultivation secures good crops.

Indonesia

In Indonesia tea is grown mainly on the slopes of the volcanic mountains of western Java. Tea estates have recently been established in Sumatra, Malaya and Borneo, though a significant contribution still comes from small holders. Fig. 22·2 shows the tea producing Areas in south east and Far East Asia.

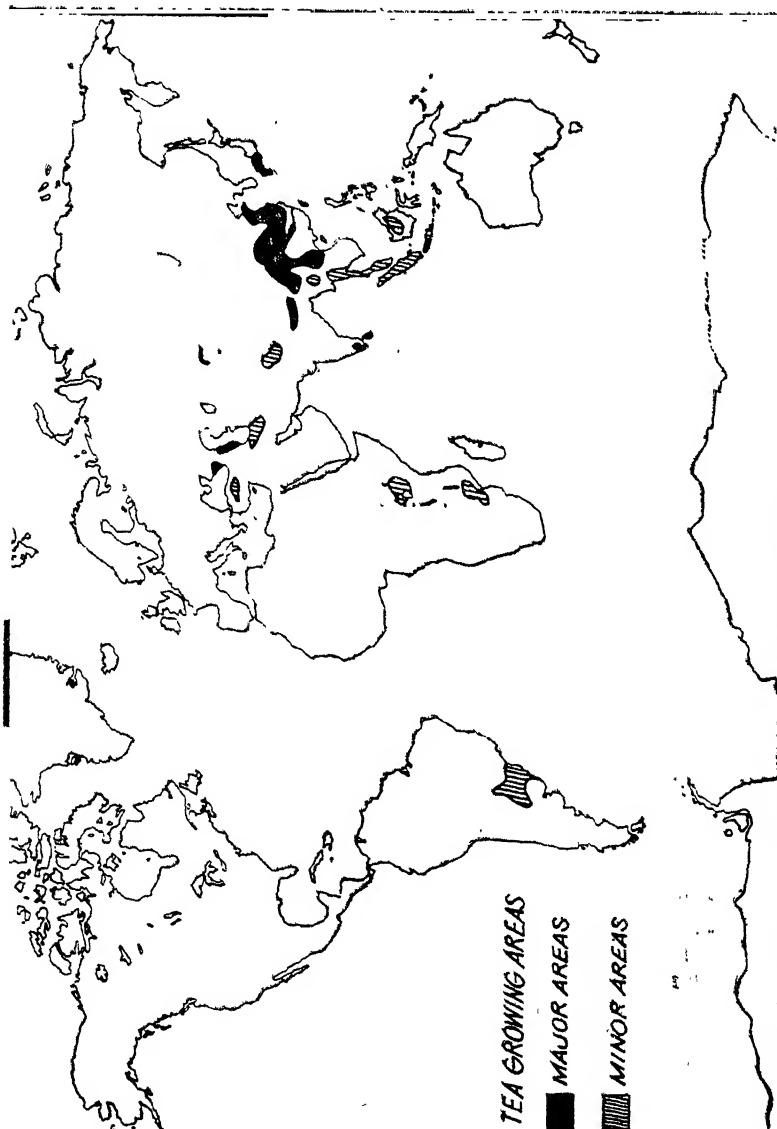


Fig. 22·1. Tea Growing areas.

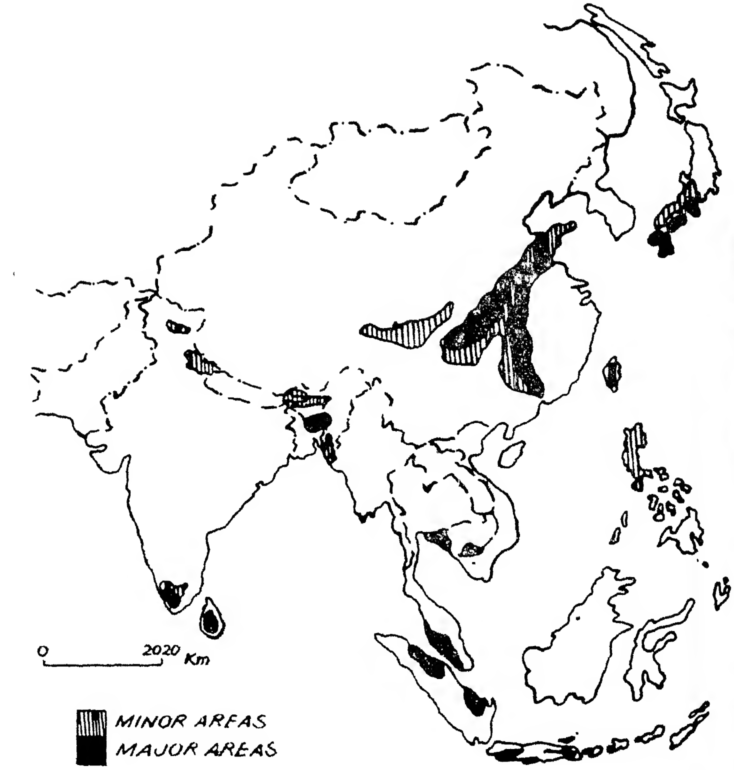


Fig. 22·2. Tea Growing Areas in S. E. Asia.

Sri Lanka

The tea gardens of Sri Lanka are located on the hills and slopes of south central regions of island. North of Ratnapura is an important tea area. Tea gardens of Kandy and Gampola are an elevation of 700 meters above sea level. The cool but humid highlands of Central Sri Lanka provide ideal geographical conditions for successful tea growing and the tea is therefore of high quality. Tea is the greatest cash crop of Sri Lanka.

India

Tea growing in India is confined in the North, East and South India.

North India—The areas of cultivation of tea in the north are Ranchi, Dehra Dun, Kumaon, Kangra valley and Kashmir. Ranchi tea gardens are situated in the Chota Nagpur Plateau, about 600 metre above sea level. The soils are regarded poor. The Dehra-

Dun tea gardens are situated in the "Doon" between the Himalayas and the Siwalik hills. A fair crop is gathered, most of it been converted into green tea and sold in Amritsar and Calcutta.

The Kangra valley tea gardens lie in the valleys on the foothills of the Himalayas in the Panjab but the climate is not very favourable. A small area of tea is also cultivated in Mandi.

Besides these, Kumaon and Uttarakhand have also a few hundred hectares of tea under cultivation. At present there are several tea gardens in Kumaon and Uttarakhand. The Benital tea garden, which is situated in Chandpur Malla, though covering 620 hectares of land, has only 48 hectares under tea cultivation. It is a small tea garden situated in the far interior of Chamoli district.

The Silkot tea garden in Lobha, is the biggest tea plantation in Chamoli district, which covers an area of 284 hectares under tea plantation.

The Mujeti tea garden is in a rotten condition. Here the tea plantation has been totally abandoned.

The Gadoli tea garden, practically no tea is produced and manufactured here. There is no factory.

The Gwaldom tea garden is situated on the border of Garhwal Chamoli and Almora and it is more easily accessible from Almora side than from Garhwal. This estate has now been awarded to ex-soldiers and the whole state has been divided into several small tea states. There are small tea estates at Talwari, Jurani and Tharali and small area of tea is also cultivated in Pithoragarh district.

In Kumaon and Uttarakhand the tea cultivation is done only by the rich pensioners in the form of plantation.

Kashmir is very suitable for growing tea so far as climate and soil are concerned. But unfortunately lack of labour and of transport facilities greatly hamper the development of tea cultivation in the state. The tea shrub grows on well drained lands as stagnant water is harmful to the plant, so that hill slopes are particularly preferred, though, if the drainage is good, if grows equally well in valleys.

East India—In Brahmputra valley of Assam most intensive cultivation of tea is found on the red alluvium soil which forms small plateau in the district of Tezpur and Bisnath. In the Surma valley the tea gardens of Cachar are in long narrow valleys running into the tributary Barak of Surma river. The country here is dotted with small hillocks interpersed with low lying belts of flat lands which are often water logged and form lakes, locally known as beel, which was formerly a swamp. These swamps have now been drained, and in many cases black soil highly charged with organic matter has been uncovered. On these soils tea flourishes exceedingly will. In addition to these flat lands, tea has been planted also on plateau land similar to that in the Brahmaputra valley.

The *Duars*—a strip of about 16 kilometres broad lying at the foot of the Himalayas, south of Sikkim and Bhutan, the most characteristic feature of this area is porous nature of soil on which tea has been extensively cultivated. Tripura is also one of the tea producing areas of India.

The tea plantation covers an area of 68105 hectares in West Bengal and it lies in the districts of Jalpaiguri and Darjeeling. The tea shrub grows best on hill slopes which allow of good drainage and prefers a light rich soil with a good supply of vegetable mould. Though the plant can stand severe frost, it does best in a warm climate, and requires most moisture in summer.

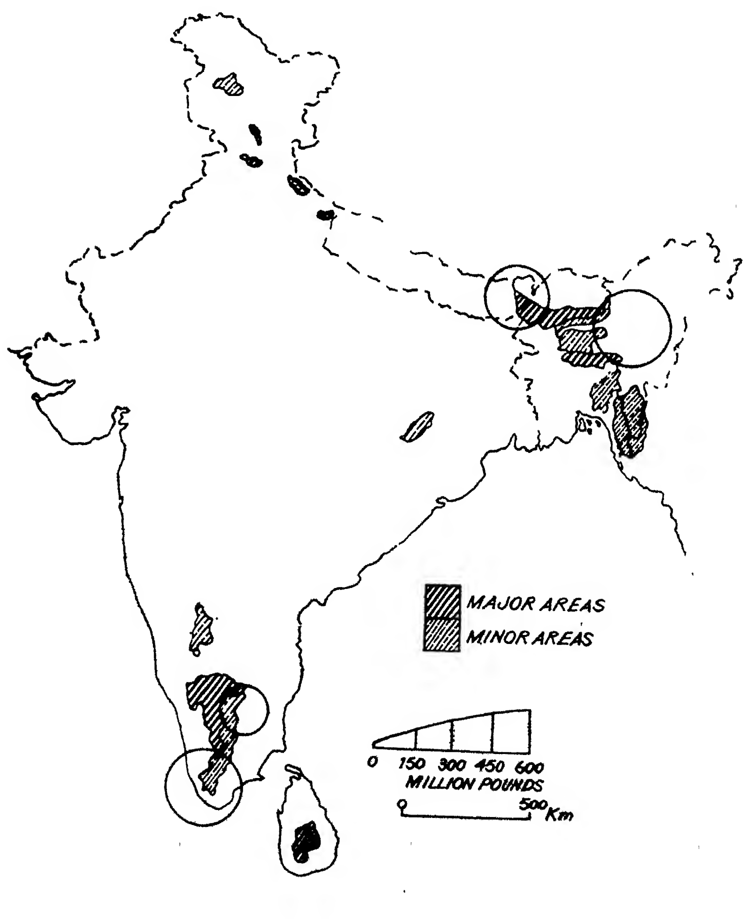


Fig. 22·3. Tea growing areas of India

South India

The tea gardens of south are located on the hills and slopes of Western Ghats. On Nilgiri hills, north of Palghat gap is an important tea area The Nilgiri—Wynand and Malabar-Wynand tea gardens are situated on the strip between the Nilgiri and Malabar coast at an average elevation of about 1000 metres above sea level. Tea gardens of Kanara and Davans are at an elevation of 1540 metre above sea level. Fig. 22·3 shows the tea producing areas of India.

Total area under tea cultivation in India is 340 thousand hectares. Nearly 76% of the cultivated area lies in Assam and in two districts of Darjeeling and Jalpaiguri in West Bengal and about 19% in South India including Annamalai in Coimbatore district, while 3% to 4% in Uttar Pradesh, Bihar and Panjab. The following table 22·1 shows the yield and area under tea cultivation.

Table 22·1

Yield and Area under tea in India

State	Area Under tea (in hectares)	Average yield (per hect. in kgs)	Production (in 000 kgs)
Assam	180065	1199	215157
W. Bengal	87989	1129	99055
Kerala	37554	1137	43263
Tamil Nadu	34587	1627	55973
Tripura	5526	727	3790
U. P.	1903	378	701
Karnataka	1866	1527	2841
Bihar	3	124	62
Himachal Pradesh	4183	226	975

The position of Assam is outstanding. In Assam the most important districts are Darrang, Sibsagar, Lakhimpur, and Cachar, Sadia, and Frontier division or Arunachal also grows a large amount of tea.

U. S. S. R.

Tea traditionally came across the Caravan routes from China, but was first grown in Transcaucasia about 1848. Tea demands warm, humid conditions without frost or drought and grows on well-drained, acid soils allowing deep root penetration, with plenty of nitrogen. The red earths of western Georgia are ideal rich in hydrates of ferric oxide and alumina oxide, formed from weathered, andesitic tuffs. The bulk of the tea consumed by the large population is precured from Communist China.

Africa

Tea is grown here only in wetter parts of the African highlands. Important tea growing states are Tanganyika, Mozambique, Kenya, Congo and Federation of Rhodesia and Nyasaland. Here tea is produced as a plantation crop by white planters.

Argentina

A soft and well drained soils of Argentina is the best for tea cultivation. Argentina is only thirty years old in tea production. Production of tea in 1960 was 7 thousand metric tons. The highest production was during the year 1968–69 when it reached a peak of 19 thousand metric tons. The year 1972 saw a further increase in production reaching 27 thousand metric tons Since the beginning of the present decade the home consumption of tea in American countries has been increasing.

Production and Area

India is the largest producer of tea in the world. About 40% of the total world production of tea came from India in 1970 and about 22% from Sri Lanka. This is about twice that of Sri Lanka, five times that of Japan, eight times that of Indonesia and twenty times that of Taiwan, as shown in table 22·2.

Table 22·2

Percentage of Tea production in selected countries

Countries	Percentage of World Production
India	40
Sri Lanka	22
Japan	8
U. S. S. R.	5·6
Indonesia	4
Kenya	3
Pakistan including Bengladesh	2·6
Taiwan	2
Others	12·8
Total percentage	**100·0**

The crop is, however, highly concentrated in a few hilly districts of India and Sri Lanka. In India, 76% of the total area under tea plantations lies in Assam (in the Brahmaputra and Surma valleys) and in the two adjoining districts (Darjeeling and Jalpaiguri) of West Bengal. The elevated region of western Ghat in Southern India (including the Kerala, Nilgiri and Coimbatore) contains 19 percent of the total. The Punjab, Kashmir, U. P. and Bihar account for the rest. There are about 7273 registered gardens with

a total area of nearly 321600 hectares under tea shrubs. Of these 238012 hectares are in Assam and West Bengal, while Tamil Nadu, Karnataka and Kerala account for nearly 71184 hectares and the rest are in Bihar, U. P., Tripura, Kashmir, Punjab and Himachal Pradesh. The tea industry of India as a whole gives employment to a labour force of almost 1·2 million. The capital invested in tea industry amounts to Rs. 113·06 crores of which about 36% is Indian and the rest non-Indian.

From the statistics we learn that out of the total production of 1027 thousand metric tons of tea Japan produced 8%, the U. S. S. R. 56%, Indonesia 4%, Kenya 3%, Taiwan 2%, Bengladesh and Pakistan 2·6 percent. The following table 22·3 shows the production and area under tea in selected countries of the world.

Table 22·3

Area and Production of tea in selected countries *

Countries	Area in 000 hectares (Average)	Production (1000 metric tons) 1968	1972
India	128·4	403	454
Sri Lanka	92·4	222	213
China	—	153+	—
Japan	18·0	85	95
Indonesia	56·4	40	50
Soviet Union	—	57	69
Pakistan (including Bengladesh)	12·4	28	—
Kenya	—	30	53
Taiwan	—	22	—
Malawi	—	16	21
Turkey	—	22	46
Argentina	—	19	27
Iraq	—	17	—
Uganda	—	15	23
Mozambique	—	14	19
Tanzania	—	8	13
Vietnam	—	4	7
World		403	454

* UN Stat Year Books 1973 and other Vols. +1960

Trade of Tea

More than 50 million kgs of tea enters foreign-trade channels each year, most of it emanates from India, Sri Lanka and Indonesia. Approximately half the amount is destined for the United Kingdom, whose per capita annual consumption is over 9 pounds, as shown in table 22·4.

Table 22·4
Per capita annual consumption of tea in selected countries (figures in pounds)*

Countries	1936-38	1960-62
U.K.	9·20	9·71
Ireland	7·74	8·30
Iraq	1·95	6·20
Libya	3 59	6.03
Australia	6·85	5·88
Hongkong	1·76	3·18
Sri Lanka	1·85	2·90
Japan	1·04	1·68
U.S.A.	0·66	0·64
India & Pakistan	0·23	0·48
Indonesia	0·27	0·28

Until recently, the tea industry of developing countries depended for its prosperity almost entirely on the foreign market. After United Kingdom, the second largest importer is the United States, but it takes only about 10 percent of the worlds total. India, Sri Lanka, East Africa dominates the export trade of tea as shown in table 22·5.

Table 22·5
Export Trade of tea in selected countries* (Fig. in million kgs.)

Exporters	1951	%	1964	1968	1970	%
India	20·6	45 0	21·0	20·8	20·8	33·5
Sri Lanka	13·84	30 2	20·6	20 8	20·7	33·2
E. Africa	1·36	3·0	4·1	6·2	7·6	11·8
Indonesia	4·06	8·9	3·2	3·7	3·6	—
China	1·21	2·8	2 8	3·3	—	—
Taiwan	1·13	2·4	2·5	1·8	—	—
Japan	0 87	1·9	0·3	0·2	—	—
Malaysia	0·08	0·2	0·2	0·2	—	—
Pak-Bengladesh	2·19	4·8	0·3	—	—	—
Others	0·38	0·8	2·0	4·7	—	—
Total	45·78	100·0	55·9	62·1	—	—

* Kotharis handbook 1966–67, quoted by K. Singh and J. Singh's Arthak Bhugool Ka Mool Thathwa.

Indeed, about 68·5 percent of all tea exports come from India, Sri Lanka and East Africa. China is a big producer and consumes most of its tea at home.

The exports of Indian tea are the largest in the world and are taken mostly by Great Britain which accounts for about 59·9% of our exports. A considerable proportion is re-exported from there to the European countries in which Russia is the most important. Russia, is however, developing her own tea plantation in Georgia. Turkey is also growing tea in the neighbourhood of Ria on the Black sea. Canada, U.S.A., Iran, Sri Lanka and Burma also take our exports. Among all the producers of tea India has the largest home market.

Practically all the exports of India tea go from the port of Calcutta to the following destinations, percentage of which is given below for the year 1965 to 1975 (average) :—

Table 22 6

Exports of Indian tea from Calcutta port*

Countries	Percentage
U.K.	59 9
U.S.R.	7·1
Egypt	7·0
U.S.A.	5·2
Canada	3·0
Irish Republic	2 8
Sudan	2 6
Iran	2 1
Turkey	1·9
Others	10·4
Total	100 0 = 1224 million Rupees

The table 22·7 shows tea exports from the Indian union to other countries :

Table 22·7

Quantity and value of tea exported from India 1970–71

Countries	Quantity (000 kgs)	Value (million Rupees)
U. K.	99525	694·0
Irish Republic	5419	43·0
U. S. S. R.	25618	19[illegible]·0

* Op. cit.

Afghanistan	11297	70·0
U. S. A.	7170	56·0
Sudan	12902	67·0
Canada	3648	29·0
Tunisia	2400	13·0
Australia	6000	36·0
East European countries	4000	28·0
Other Countries	208430	1480·0

COFFEE

Coffee the second after tea, is most widely drunk of non-alcoholic beverages. It is a leading tropical commodity in international trade and is the chief export crop of Latin American and Carribean countries.

Ecological Conditions

The coffee tree requires heat, humidity abundant rainfall and a rich, well-drained soil. The principal coffee growing regions of the world have an average annual rainfall of about 135 to 140 cms. In a few places coffee is grown with as little as 88 cms. of rain ; in others, with as much as 154 cms.

Climate is deciding factor in coffee cultivation. Coffee plant can be classed as a Tropical plant but is very hardy, and provided that the growing season is long, warm and moist, it is injured by winter frost. A well distributed rainfall throughout the year is essential for the cultivation. Daily rainfall followed by a strong sun when the berries are ripening and dry weather at harvest time are highly desirable.

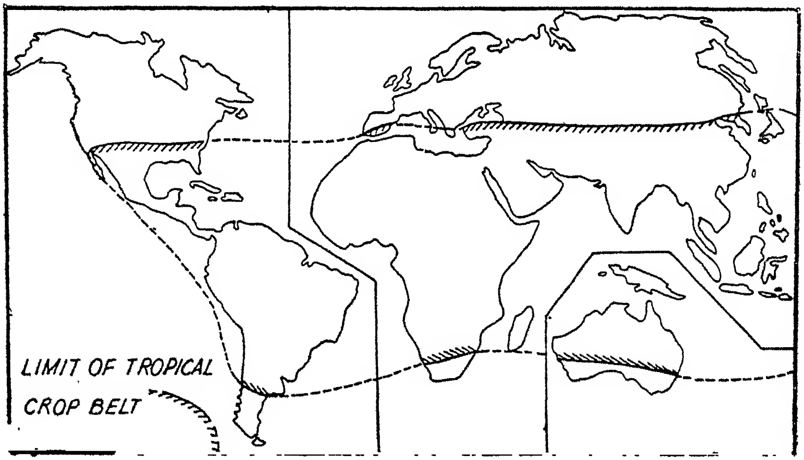


Fig. 22 4. Approximate limits of tropical crop belt.

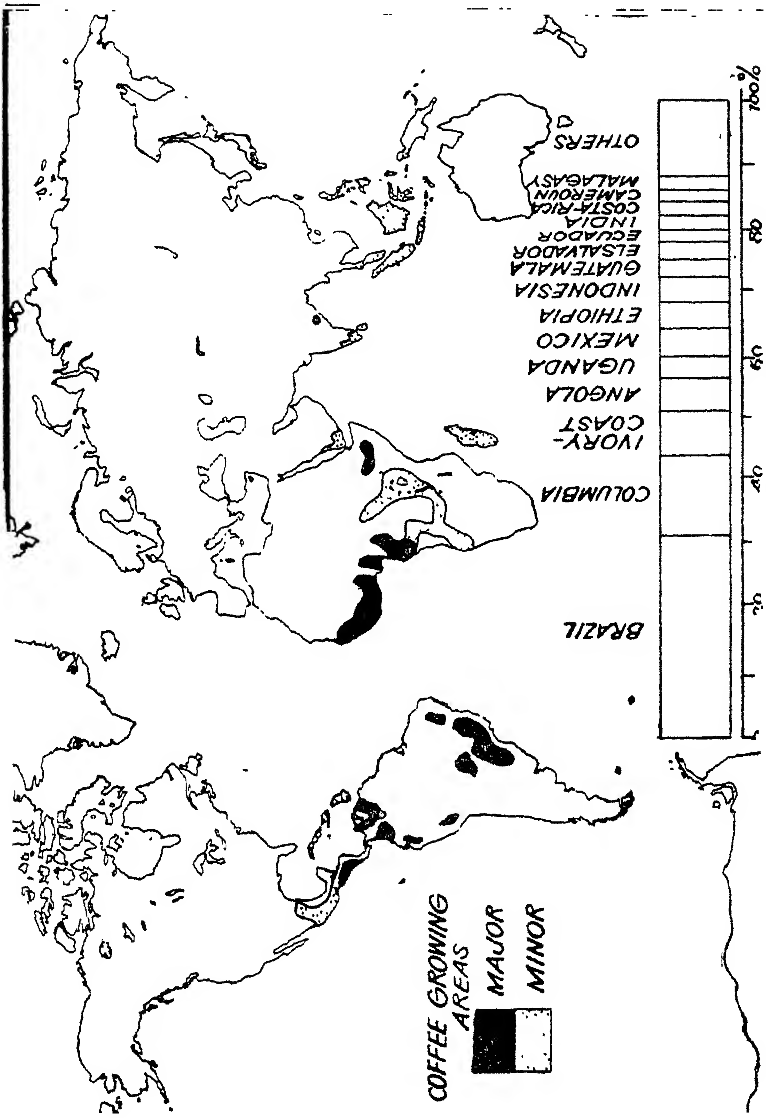


Fig. 22·5. Coffee growing Areas of the World.

Most coffee is grown where the average annual temperature is between 20° to 25°C. Although coffee requires a hot climate, in many regions the full blast of the sun is too hot for it, and high trees are scattered over many plantations to cast some shade. Tall leguminous plants are used in Brazil and not only provide shade but also enrich the soil with nitrogen. Shade is not necessary for South Brazilian production near the Tropic of Capricorn, but shade is essential on Colombian plantations much closer to the equator.

The production of coffee which requires an altitude of 915 to 1220 metres above the sea level for its proper nurturing and a temperate climatic conditions in a tropical zone, is now mainly distributed between 30° North and 30° South latitudes which limits the tropical crop belt as shown in fig. 22·4.

Coffee Growing Regions

Ninty percent of the world's coffee is grown at elevations ranging from 305 to 1830 metre. Hilly and mountainous lands are the best sites for coffee trees, as slope land facilitates drainage, avoids excessive exposure to the sun, and affords protection against frost and wind. Coffee is centred in the tropical regions of Latin America, Africa and Indonesia. Fig 22·5 shows the coffee growing regions of the world. In lower elevations, which have a higher rainfall, the more delicate but better quality *Arabica* coffee has given place to the harder but coarser *Robusta* coffee.

Brazil

Brazil normally provides about half of the world's coffee, and Colombia produces about one-third as much as Brazil. Despite the development rapidly proceeding in other spheres of production, Brazil is still largely an agricultural country. There is a wide range of soils and climates which enable a diversity of crops and plants to flourish. Brazil is the world's largest producer of coffee. The country's coffee output of 50 percent of the world total. The bulk of the coffee crop is grown in the states of Parana (most important and productive region) ; Sao Paulo, Matto Grosso, Minas Gerais, Riode Janeiro and Espirito Santo. Large plantations of over 100,000 trees are the rule. The Government regulates the sales, the growers receive a variable subsidy on each bag. The Southern part of Brazil is eminently suitable for the cultivation of coffee, but soil erosion is Brazil's principal problem The soil conservation programme of the Agricultural department and coffee board includes the protection of arable land by mechanically dug, graded contour furrows (Terracing), the planting of grass buffer strips, grass runways and trees and the construction of small dams.

Colombia

Agriculture is the most important sector of the Colombian economy. Coffee is the most important agricultural product. It

accounts for one-tenth of the gross domestic products, one-tenth of the central government revenues and almost two-thirds of the foreign exchange earnings of the country. Approximately two million Colombians make their living from coffee farming. Colombian coffee is of mild, high quality variety and has the highest selling price of all coffees in the international market. About three-fourths of Colombian coffee is grown west of the Magdalena River and south of Medellin, chiefly on the slopes of the central Cordillera in the departments of Caldas and Antioquia. Coffee is also grown on the western slopes of the eastern Cordillera around Bucaramanga and Bogota.

In Venezuela and Ecuador the coffee-growing areas lie much nearer the sea.

Guatemala and Mexico

The most important crop of Guatemala is Coffee, which is grown on the mountain slopes. The coffee crop for 1972-73 amounted to 2·3 million quintals. Much of the soil is fertile and climatic conditions allow a variety of crop to be grown. Coffee is mostly grown for domestic consumption and for exports. Guatemala and El Salvador are two most important coffee exporters of central America.

Coffee in Mexico is chiefly grown in the southern portion of the Sierra Madre oriental and in the highlands of Chiapas to the south of the Isthmus of Tehuantepec.

Coffee is also grown in the Blue mountain of Jamaica and Puerto Rico.

Asian and African Producers

Many countries of Asia and Africa produce considerable quantities of coffee but the old world as a whole still only accounts for just over a third of the world total. Important African coffee producers are Kenya, Uganda, Zaire, Cameroon and Ivory Coast. The Ivory Coast is the most prosperous of the west African regions. Coffee is the most important of the agricultural crops of the Ivory Coast ; planting cover 650,000 hectares, provide a living for about 2,000,000 people (almost half the total population) and the crop harvested in 1970 was 310,000 tons.

In Asian countries coffee is grown on the slopes that face the lower plain along the Red Sea in Yemen, the Southern part of the Arabian Peninsula. Elsewhese in Asia, the principal production of coffee occurs on the volcanic slopes of Java and Sumatra.

India

Coffee growing was established on a firm footing in southern and India in the last century, between 1830 and 1840, first in Karnataka and then in Wynaad. Nilgiri and Shevaroi hills. Later in 1854, the first coffee plantation in Coorg now in (Karnataka) was opened from which a great expansion has taken place.

The coffee industry of India is confined to Southern India comprising Tamil Nadu, Karnataka and Kerala. Of the total area under coffee Karnataka accounts for more than half, and Tamil Nadu and Kerala 22 percent each.

In Karnataka the coffee plantations are mostly confined to the south and west especially in the districts of Kadur. Shimoga, Hassan and Mysore. In Tamil Nadu the coffee plantations are found mostly in the south west from North Arcot to Tirunvelly. Nilgiri is the important area In Andhra Pradesh it is grown in Vishakhapatnam.

Area under coffee cultivation in India

The present area under coffee cultivation is 139,478 hectares, made up of 84362 hectares under *Arabica* and 55,116 hectares under *Robusta* coffee. The following table 22·8 shows the area under coffee cultivation in India.

Table 22·8

Area in thousand hectares

Year	Arabia	Robusta	Total
1965–66	78	51	129
1967–68	78	50	128
1969–70	78	50	128
1971–72	78	51	129
1972–73	84	55	139

Coffee Production

Although Indias coffee is claimed to be the finest and best quality, India produces less than 2 percent of the total world production, the biggest producer being Brazil with 40%, Colombia 9%, Ivory Coast 5%, Angola 4 5%, Uganda, Mexico, Indonesia 4% each, Ethiopia and Guatemala 3·5%, El Salvador 3% and rest the others. Table 22·9 shows the coffee production in the world.

Table 22·9

Coffee Production (thousand metric tons)*

Countries	1965	1671	1972
World	4996	4950	4548
S. America	2967	2469	2093
Brazil	2294	1795	1475
Colombia	492	468	432
Venezuela	54	59	66
Peru	48	71	66
Ecuador	66	59	58

Africa	1150	1302	1382
Ivory Coast	273	268	270
Angola	220	195	200
Uganda	168	228	204
Ethiopia	140	175	175
Cameroons	74	88	93
Kenya	39	59	62
Malagasy	55	58	62
Congo Dem. Rep.	59	3	2
North and Central America	640	766	760
Mexico	159	186	198
El Salvador	109	160	128
Guatemala	123	173	126
Costa Rica	62	81	80
Asia	232	384	350
Indonesia	108	188	189
India	62	110	68
Philippines	44	50	52
Oceania	13	28	30

From the statistics we learn that out of the total production of 43000 tons of coffee (both Arabica and Robusta) Karnataka produced 54%, Tamil Nadu 36 percent, Kerala 7 percent, Andhra Pradesh and Andaman Islands 1·5 percent each. The following table 22·10 shows the production of Arabica and Robusta coffee in India.

Table 22·10
Production of Coffee in India
(Production in tons)

Year	Arabica	Robusta	Total Production
1968–69	49700	23800	73500
1969–70	37800	25800	63600
1970–71	58000	51000	109000
1971–72	—	—	110000
1972–73	—	—	68000

Trade of Coffee

Two countries of South America especially Brazil and Colombia dominate production and export of world coffee. Export of coffee has also increased from 2801 thousand tons in 1963–65 to 3216 thousand tons in 1968. The principal markets for coffee from deve-

loping countries to developed countries are the United Kingdom, France, Germany, Holland, Australia, U.S.A. and U.S.S.R.

India produces some of the best coffee in the world, and yet her exports are negligible, especially because of the competition from Costa Rica, Ivory Coast, and Colombia. The consumption of coffee in India is very low. About 96 percent of the coffee available for home consumption is consumed in Tamil Nadu, Karnataka and Kerala. The rest of the country consumes only 4 percent.

Colombia ranks second only to Brazil in coffee production, and her share of the world's coffee exports has increased from 4 percent in 1909–13 to 14% in 1935–1939 and 29% in 1960–65. The United States is the world's largest consumer of coffee taking approximately 60% of the coffee exported. The United States consumes more than 1496 thousand tons of coffee, which is shown in table 22·11.

Table 22·11
Trade of Coffee

Region/Country	1966	1967	1968
	Exports in thousand tons		
World	**2975**	**3027**	**3216**
Developing Countries :—			
Brazil	1010	1004	1080
Colombia	334	366	395
Latin America	553	566	593
Africa	938	900	983
Asia and Oceania	140	191	165
	Imports in thousand tons		
World	**2967**	**2948**	**3300**
Developed Countries	2673	2678	3013
E.C.M.	762	790	845
Other European Countries	471	481	510
U.S.A.	1294	125[illegible]	1496
Others	146	153	162
Developing Countries	**175**	139	157
Latin America	51	46	47
Africa	70	52	62
Asia	54	41	48
Centrally Planned Countries—	**119**	131	130
Eastern Europe	91	106	100
U.S.A.	28	25	30

CACAO (Cocoa)

Cocoa is a typical commercial crop of the tropical rainforest climate of Africa and America. The cocoa bean or seed of commerce is obtained from the fruit of the evergreen tropical tree whose botanical name is *Theobroma Cacao*.

Ecological Conditions

The cultivation of cocoa requires a light soil, perfectly rich in organic matter. The rich humus contain alluvium and grey soils of the flood plain suit it well. Much rainfall is not required, a rainfall of 120 to 130 centimetres is quite enough if it is distributed throughout the year. Cocoa cannot stand in low temperature, plant need a temperature of 24°C to 30°Centigrade. Frost is harmful for cocoa pods. Dry weather is required at the time of ripening. One of the most critical limits for cocoa growing is that set by winds. The heavy pod hanging to the tree by a relatively weak stem will easily fall to the ground during stormy weather. Consequently the high percentage of calms in the tropical rainforest climate is a significant factor.

GROWING AREAS

South America

The cocoa is indigenous to tropical America and was first found growing wild in lowland Central America, from Panama to the Yucatan peninsula and in the river basins of the Amezon and the Orinoco. In the beginning of the sixteenth century, cocoa cultivation in tropical South America occupied only a minor position, but when Hernando Cortez, the Spanish conqueror of Mexico, brought some cocoa beans back to Spain, it soon became a popular drink in many European countries. Cocoa has now assumed great importance and plays a vital role in the economy of tropical countries of South America.

Cocoa is important only in Brazil, Ecuador, Colombia, and Central America. Haiti, Dominican Republic and Costa Rica are the only producers outside the main continent. Brazil produces more than one half of all cocoa grown in Latin America. The district of Bahia in north eastern Brazil accounts for 90% of the Brazilian output, the remainder 10 percent coming from around Espirito Santo, along the eastern Brazilian coast north of Sao Paulo. The cocoa growing belt of Brazil stretches about 560 km. long and 14 km. wide along the sea coast, as shown in fig. 22·6.

Ecuador, which was major cocoa producer of the world now only produces 4% of the world total. Cocoa cultivation in Ecuador is mainly concentrated in the Guayaquil lowlands between the gulf of Guayquil and the foothills of the Andes.

Small amount of cocoa is also grown in Colombia, Peru and Venezuela. Cocoa is here grown chiefly for home consumption. Venezuela ranks fourth after Brazil, the Dominican republics and Ecudor.

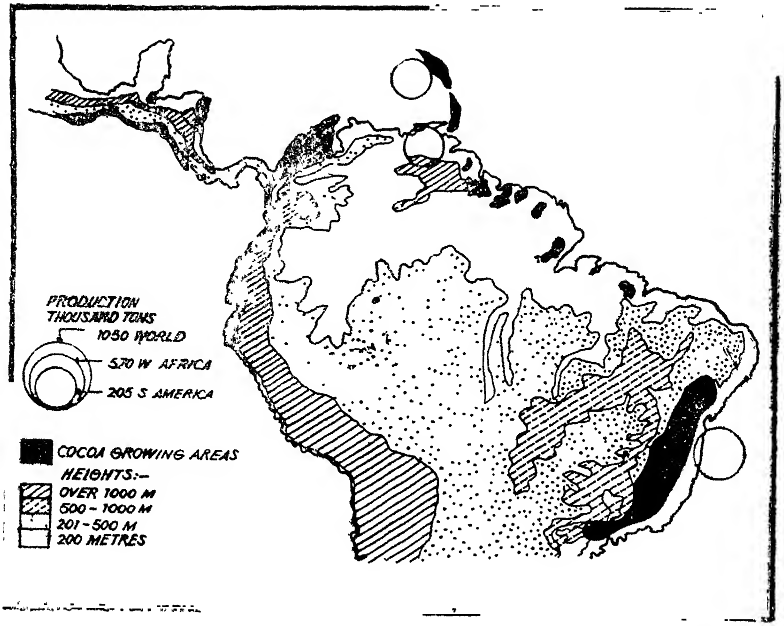


Fig 22 6 Cocoa Producing areas in S. America.

Cocoa cultivation is also important in Haiti, Mexico, the Dominican Republic and Costa Rica. In the Dominican Republic the intermontane protected valleys afford ideal situations for cocoa groves. Many such places are available on rugged lands such as those of the mountainous West Indies islands.

Africa

The position of west Africa is outstanding. In western Africa the most important areas are Ivory Coast, Ghana, Togo, Dahomey, Nigeria, Cameroon, Liberia and Sierra Leone. Fig. 22·7 shows the cocoa growing environment and 22·8 shows the important cocoa producing areas of western Africa.

The Ivory Coast is the most important cocoa producing area of western Africa and one of the prosperous country. Cocoa once the second most valuable crop, has been supplemented by wood. Export (particularly of hard redwoods, has developed at such speed and on such a scale that, although plans for replanting are being implemented, there is some risk of temporary over-felling. 180,000 tons of cocoa were harvested in 1970.

Ghana is second important producer of cocoa. The area under cocoa cultivation is about 1·2 million hectares The main areas of concentration of cocoa are main land, about 720 km. from sea Coast. In Ghana, roughly more than 60% comes from Takoradi, Kumasi and Accra triangle.

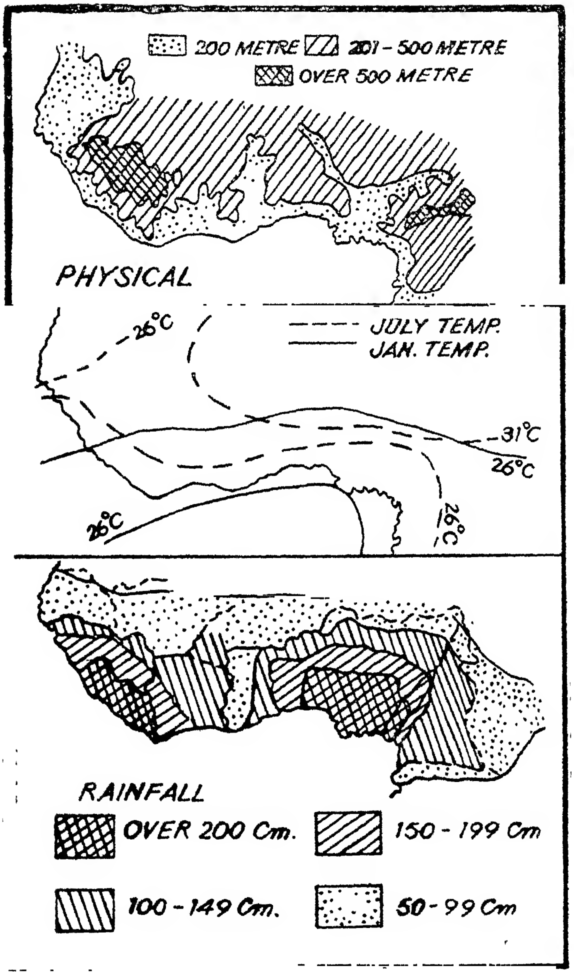


Fig. 22·7. Cocoa growing environment

Nigeria ranks third among west African cocoa producers, being surpassed by Ivory Coast and Ghana. The leading cocoa region is in the south, west around Ibadan. The area under cocoa cultivation covers about 200,000 hectares,

The west African countries, especially Ivory Coast, Ghana and Nigeria, together account for nearly 60% of Africa cocoa. The remainder comes chiefly from Cameroon, Liberia and Sierra Leone. Small amount of cocoa is also grown in Equatorial Guinea.

Cocoa cultivation is not important in Asia. Eastern Sabah of Malaysia is eminently suitable for the cultivation of cocoa.

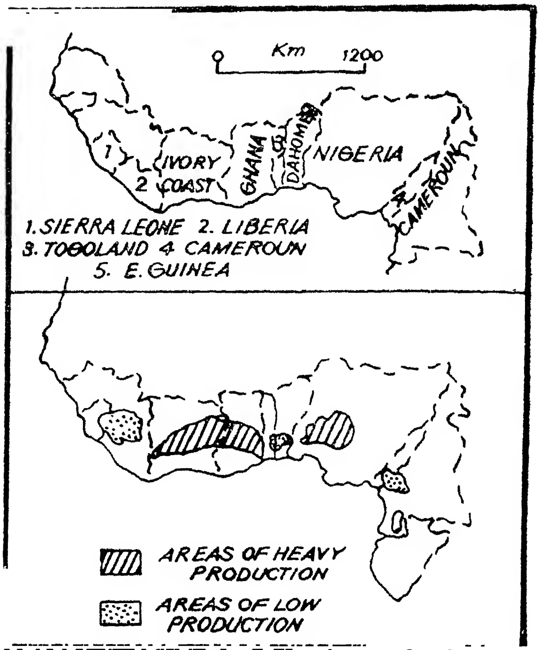


Fig. 22 8. Cocoa growing areas

Cocoa cultivation is gaining importance in south east Asian counries but cultivation is restricted in small area at present.

Production

From the statistics we learn that out of the total production of 1477 thousand metric tons of cocoa west African countries produced 68% of the world total, South America 20%, Caribbean and Central American countries only 7%, Oceania 3%, New Guinea 1·6 percent and Asia only 0·4 percent. The following table 22·12 shows the production of cocoa of the world.

Tahle 22·12
Production of Cocoa beans
(Figures in thousand metric tons)*

Region/Countries	1968	1971	1972
World	**1227**	**1640**	**1477**
Africa	832	1158	1023
Ghana	332	470	420
Nigeria	183	257	241
Ivory Coast	132	225	181
Cameroons	102	123	162
Togo	19	27	29
Equatorial Guinea	35	22	15
South America	**272**	**327**	**296**
Brazil	149	212	185
Ecuador	70	71	61
Colombia	19	21	23
Venezuela	24	19	19
Caribbean and Central America	**82**	**84**	**95**
The Dominican Republic	31	27	43
Mexico	24	35	30
Costa Rica	8	7	5
Oceania	**32**	**60**	**53**
New Guinea	27	30	23
Asia	**9**	**11**	**11**

Trade of Cocoa

The west African countries especially Ivory Coast, Ghana, Nigeria and Cameroon, together account for nearly 80 percent of world cocoa. The rest 20 precent comes from Brazil, Venezuela, Ecuador, Central American states and Indonesia,

Europe, constantly increasing its consumption of cocoa relatively to population, has been growing nothing and less able to supply its own wants in this article, and thus becoming more and more dependent on supplies from western Africa and South America. The great cocoa importing countries are those of the west European countries and west Germany stands at the head of the list, taking the largest share of the cocoa export from all the great cocoa exporting countries. Fig 22·9 shows the cocoa trade.

In U.S.A. they are one of the chief articles of diet of the people, so that on account of the United States cocoa trade will serve to give a general view of the cocoa supply of the whole

* U.N. Stat. Year Book 1974 and other publications.

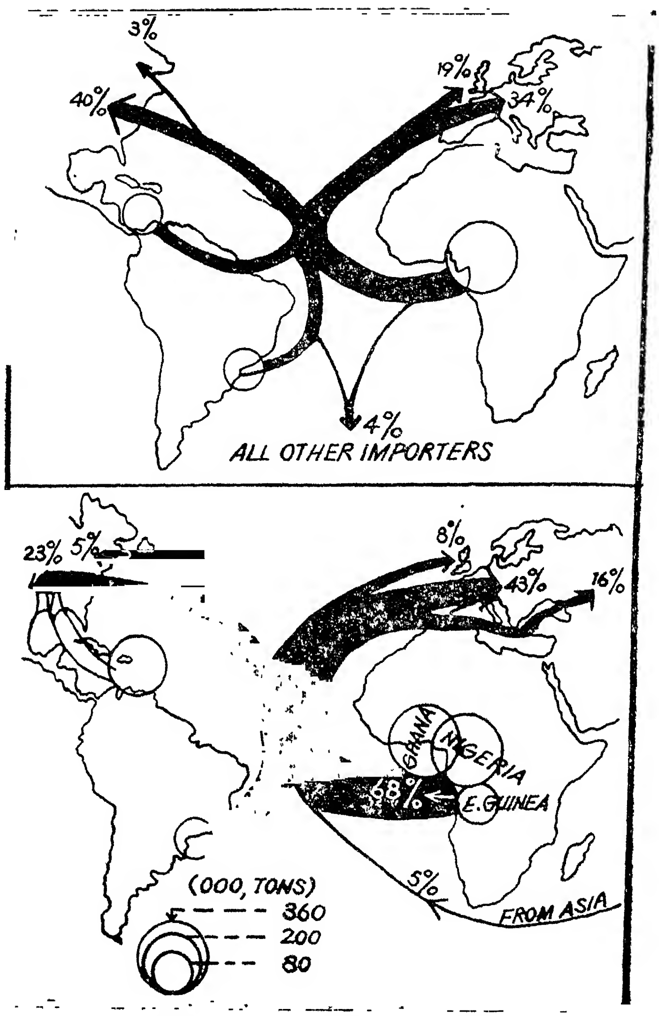


Fig. 22 9. Cocoa Trade of the World.

world. New York city is the major cocoa trading centre of the world, and from New York they are exported in large quantity to European countries and elsewhere. Thus the major importers are theU.S.A (which takes 25 to 30 percent) the United Kingdom, West Germany, Neatherlands, Switzerland and Spain.

TOBACCO

The cultivation of tobacco is one of which great care is bestowed. Like sugarcane, the crop carries with it considerable profits, but it is almost entirely grown upon good land and both manure

and water are available. Speaking generally, the crops is grown in rotation with other crops, but it is not unusual in some states of India to grow tobacco years after year on the same land.

In Andhra Pradesh and Maharashtra it is, the common opinion that the quality of tobacco is much improved by the continuous growth for many years on the same spot, and fields can be pointed out which have produced tobacco for ten years and more and are especially noted, the produce often fetching quite fancy prices.

Ecological Conditions

Tobacco requires a good soil and heavy manuring. The best kind is a well-drained, friable, sandy loam, not too rich in organic matter, but rich in mineral salts like potash, phosphoric acid and iron. Light soil which allow a full development of the roots of tobacco are the best for it. But heavy soils are used in India for growing *hookah* tobacco.

The plant requires a frost-free period of 150 to 200 days and a warm growing season. It is, therefore, grown largely in the frost-free regions of the world.

Temperature exceeding 18°C in the warmest mouth are ideal. The crop requires moderate rainfall and rich, regularly fertilized soil.

In India tobacco is grown mostly wherever the soil is a rich sandy loam with water only one or two metres below the surface. Shallow wells are dug all over the tobacco growing areas, and during certain stages of the growth of the crop hand irrigation is done daily. Tobacco is grown principally as a garden crop, but sometimes also as a dry or unirrigated crop, the seed-bed only being watered by hand. The irrigation is followed not only to supply moisture, to the roots but also to wash the dust from the leaves.

Although the tobacco plant is injured by frost, but it is also grown beyond the limits of tropical crop belt (see fig. 22·4). It grows in a comparatively short period, so that profitable crops ripen as far south and north of 50°, as shown in fig. 22·10, while it is at home throughout the tropical and sub-tropical regions.

Cultivation

The process is the sowing of tobacco seeds in small beds. When the plants attain a height of 10 to 12 cms , it is carried to the larger fields and the plants, planted in the wet soil.

In most of the developing countries, curing of tobacco as conducted by the people is done in a very primitive way. The leaves are not removed one by one when ready for picking, but after a few spots have begun to appear on the lower leaves, the entire plant is cut off close to the ground, and is left exposed to the night dew. Next day the plants are arranged is small circular heaps, about one metre high, with the staks outwards At the close of the day the heaps are opened, and the leaves are spread out for night. The next day they are heaped again, and so on until

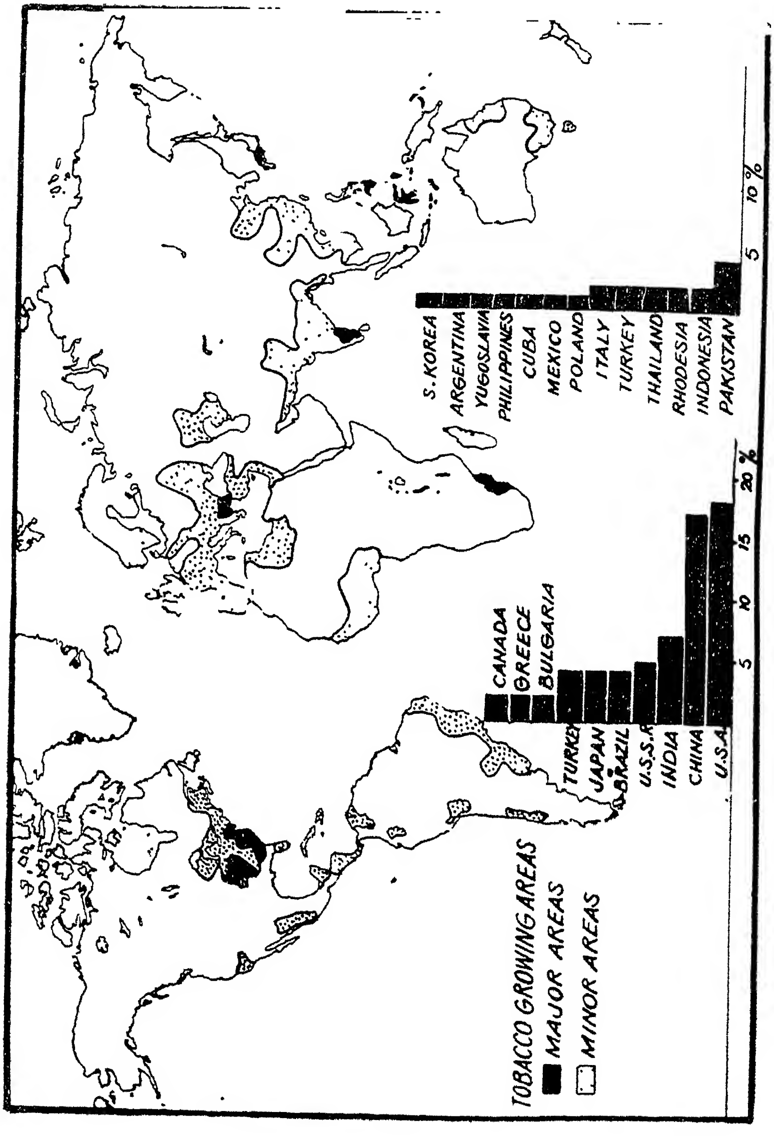


Fig. 22·10. Tobacco Growing Areas.

after about five days they begin to turn yellow. Then the plants are huge upon horizontal poles for 10 to 15 days, the stalks being pressed close to each other. After this the leaves are again packed in square heaps, and these heaps are opened and re-packed every two or three days The leaves begin then to sweat and finally to turn black. This blacking is a sign of fermentation being finished, and the leaves are then stripped off the stalk and tied up in bundles and baled Often, water are sprinkled on the leaves after fermentation is over. This process of curing is evidently a very crude one, and admits of very great improvement.

It also requires a large labour force since its cultivation is a highly specialized activity involving almost entirely hand labour, even in the west or especially in U.S.A.

The cultivation of tobacco is a painstaking task. Seedbeds must be carefully prepared and seedlings must be transplanted, thinned, regularly weeded and inspected for pests. The top shots are usually removed for the plant to stimulate leaf development. The harvesting, grading and curing of the leaves are also carried out by hand.

Varieties

The Indian variety of tobacco (*Nicotiana Rustica*) is a more rapidly growing species othe than the variety generally grown in temperate regions of the world.

Nicotiana rustica is the type grown in the mjaor producing countries, including all the tropical countries of Asia, Africa and Latin America.

Turkish or *oriental* variety is grown mostly in oriental countries of Asia aud Oceania. It can survive even in arid condition and is disease resistant.

Virginia tobacco is mostly grown in western countries especially in North America It also requires a liberal, well distributed rainfall or its equivalent in irrigation water. For the water requirements of the plants are high and very sensitive to defective drainage or water logging of the soil. It needs well drained soil. Virgina estate of North America is mostly grown *virginia* tobacco since seventeenth century settlers.

In the cultivation of tobacco it is the quality of leaf rather than quantity that is aimed at. High yields of leaf always imply a rank vegetative growth. For good *cigarette tobacco*, therefore, relatively low yields are essential to the production of leaf of the highest quality.

Tobacco Producing Areas

Tobacco is grown in almost all the tropical countries of the world, but its cultivation is mostly concentrated in U.S.A., China, India, U S S.R., Brazil, Japan, Turkey, Pakistan, Bulgaria. Greece,

Canada, Indonesia, Rhodesia, Thailand, Italy, Poland, Mexico, Argentina, Yugoslavia, Philippines, Cuba, France etc.

U. S. A.

In the United States the Virginia—Carolina tobacco belt, running from Southern Maryland through the middle part of Virginia and North Carolina and on into South Carolina, has been the leading tobacco belt of the United States. More than 50% tobacco of America is grown in this belt. Rich mond of Virginia and Wilson, Durham and Winston—Salem are leading tobacco markets.

The second important belt is Kentuky—Tennessee belt. The important tobacco producing states are Northern Carolina, South-eastern Indiana and Southern Ohio.

China

China ranks second in tobacco production. Tobacco in China was introduced from the Philippines in the sixteenth century. It is now grown in most provinces. In China the cultivation is concentrated in Honan, Hupei, Szechwan, Yangtze and HwangHo valley.

India

India ranks third in tobacco production. Tobacco is grown in almost all the estates of India, but its cultivation is mostly concentrated in the river valleys, deltas and low lying coastal areas in Andhra Pradesh, Karnataka, Maharashtra etc.

More than 2/3 of the hectarage and output of tobacco in India are found in the states of Andhra Pradesh, Tamil Nadu and Maharashtra. In Tamil Nadu the most important districts producing tobacco are Madurai, Coimbatore, Tiruchirapalli, Thanjavur etc.

In Maharashtra the important tobacco producing districts are Kolhapur, Sangali, Giraj, Belgaon, Satara etc.

In Uttar Pradesh the most productive tobacco growing districts are Varanasi, Mainpuri, Bulandshar, Saharanpur, Meerut and Farrukhabad etc. Table 22·13 shows the production and hectarage of tobacco in India.

Table 22·13

Area and Production of Tobacco in India

State	Area (in thousand hectares)	Production (in million kgs.)
Andhra Pradesh	204·9	126·8
Assam	10·3	N.A.
Bengal	13·9	12·8
Bihar	13·9	17·2
Gujarat	88 7	99·8

J. & K.	0·4	0·4
Kerala	0·7	0·9
Madhya Pradesh	2·51	1·1
Tamil Nadu	16·1	23 8
Maharashtra	14·0	7·8
Karnataka	33·9	16 2
Orissa	13·8	5·6
Panjab	0·3	0·2
Haryana	0·9	0·6
Rajasthan	4·2	2·5
Uttar Pradesh	12·9	11·6
Delhi	0·1	0·1
Tripura	1·3	0 4

The Indian hectarage to tobacco during 1920–21 was 401 thousand hectares as against .57 thousand hectares in 1950—51. The average area under tobacco during 1964-65 was 423 thousand hectares. The production of tobacco in 1950-51 was only 2,61,00 tons. The highest production was recorded in 1968-69 when it reached a peak of 361 thousand tons. The year 1973-74 saw a further increase in production reaching a new height of 369000 tons. The following Table 22·14 shows the production and hectarage in India.

Table 22·14

Production and hectarage of Tobacco

Year	Area thousand hectares	Production 000 tons
1970–71	433	338
1972–73	434	368
1973–74	437	369

U. S. S. R.

The Soviet Union ranks fourth after U. S. A., China and India. Tobacco is grown throughout warm, moist Southern Russia, but is generally poor in quality, though the best Crimean and Caucasian types are reputedly as good as Balkan tobacco. About a quarter of the sown area is in the Ukraine, principally in the Crimea, Georgia, Moldavia and the Krasnodar region are also important, where air-curing is practised. The central black earth districts, western Siberia, and the Volga, also grow *Makhorka* (a strong, dark, pipe tobacco) which is tending to give way to yellow tobacco.

Other Nations and Areas

Tobacco is grown throughout nearly all the heavily populated parts of Japan and Pakistan, the nations of fourth in world output. Most of the remaining areas of production, regardless of world rank, have increased their output during that time. One of the most striking increase has occurred in Rhodesia, where the output has quadrupled during the past quarter century.

In continental perspective. Asia is the leading producer, supplying over 50% of the world total, with North America producing an additional 30 percent. People's Republic of China and India (17 and 7 percent respectively) plus such important producers as Japan (4% of world total), Pakistan 4%, Thailand 2%, and the Philippines 10%, give Asia its leading role. Table 22·15 shows the production of tobacco in selected countries of the world.

Table 22·15

Production of Tobacco in selected countries (Figures in thousand metric tons*)

Region/Country	1968	1971	1972
World	4740	4588	4763
North and Central America	1013	1028	1067
U.S.A.	777	774	793
Canada	99	102	83
Mexico	62	83	83
Cuba	46	27	54
U.S.S.R.	245	288	300
Asia	—	2074	2115
China	850	785	790
India	369	350	409
Japan	193	150	142
Turkey	161	174	173
Pakistan	169	113	87
Indonesia	110	60	63
Philippines	65	56	57
Thailand	90	49	51
Burma	—	42	52
Europe	587	567	645
Bulgaria	105	120	158
Greece	87	88	85
Poland	83	70	75

* U. N. Stat. Year Book, 1973 and other publications.

Itlay	74	79	84
Yugoslavia	43	44	62
Rumania	—	30	38
France	51	43	48
South America	412	398	393
Brazil	250	255	240
Argentina	59	62	71
Colombia	43	38	36
Africa	196	216	223
S. Rhodesia	62	65	73

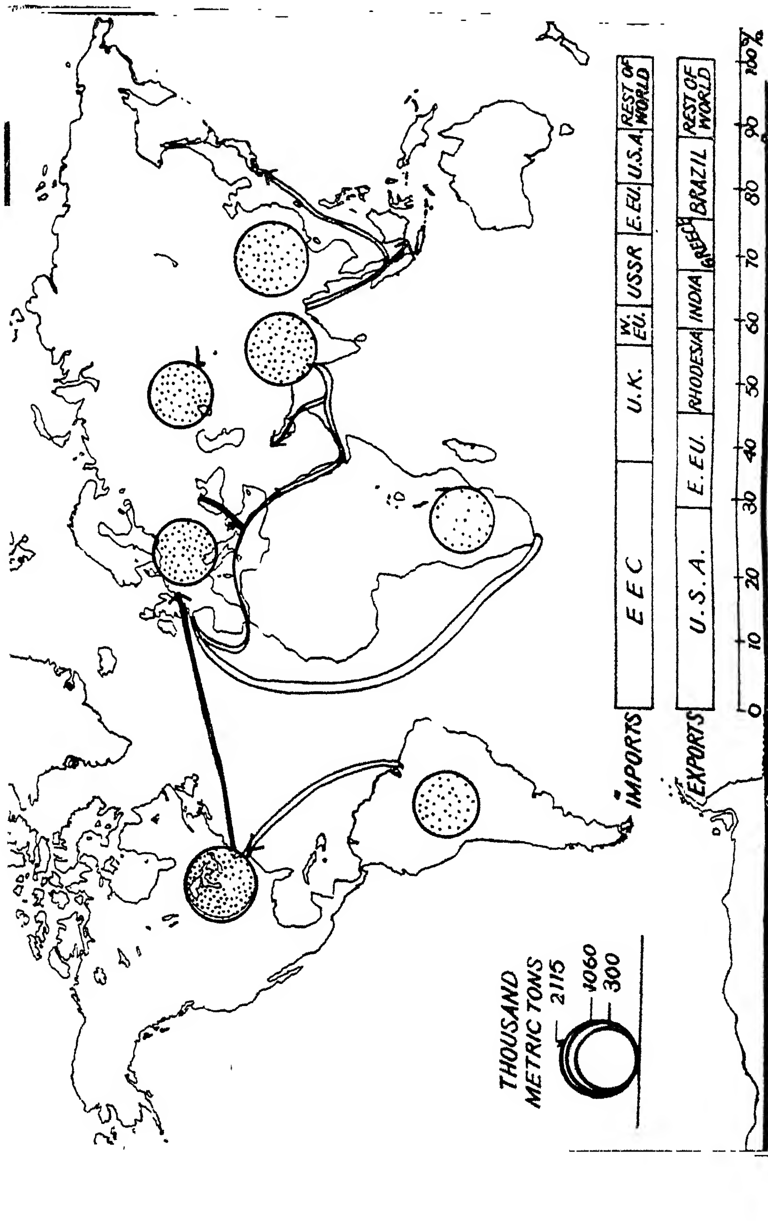
International trade

Less than one-fifth of all tobacco is exported. The United States of America dominates international trade in tobacco, accounting for approximately one-third of all exports and more than one-twelfth of all imports. Fig. 22 11 shows the imports and exports of the world. Approximately three-fifths of all imports move to northwestern Europe, with the EEC accounting for nearly two-fifths, and the United Kingdom alone responsible for nearly one-fifth. International trade of tobacco is thus predominantly a movement from a technically advanced nation to other technically advanced nations, all located in outside the Soviet block.

Most of the other large producers serve mainly the local market but some minor producers have significant exports just like Cuba, which produces excellent cigars ; Greece and Turkey, which produce the aromatic Turkish Tobacco and until U.D I., Rhodesia which supplied Virginia variety to Britain. Indonesia, once a major producer of special tobaccos has turned over to cheaper varieties, mainly for local consumption.

The United Kingdom, Germany, France and other European countries lead all nations in imports and British imports accounting 142 thousand metric tons annually. The United States, Turkey, Greece, Southern Rhodesia and India are the chief exporters.

About 80% of the total output of tobacco in India is consumed internally. In 1960–61 consumption of tobacco in India was 648·32 million lbs. In 1962–66 despite the increasing consumption of tobacco India exported 45 to 50 thousand tons of good quality tobacco and earned the foreign exchange of the value of Rs. 10 to 12 crores per year. U.K , U.S.A., Sri Lanka, Aden, Belgium, Singapur, Nepal, Poland etc. were the chief importing countries. The main importing countries of Indian tobacco are given in following table 22·16.



g. 22·11. International trade of tobacco

Table 22·16
Exports of Indian tobacco

Countries	Exports (in million kgs)
U K.	14·4
U.S.S.R.	34·5
Japan	4·4
Nepal	2·2
G.D.R.	1·5
Indonesia	1·3
Netherland	1·3
Ireland	1·7
Bangladesh	18·5
Others	83·0
Foreign exchange earned in Million Rupees	571

A record exports of tobacco valued at Rs. 325 million was made during 1971 against 334 million rupees during the period in 1970. The highest value was recorded in 1974–75, when it reached a peak of 571 million rupees. The importance of Indian tobacco is considerable as a money crop. It is used in large quantities in the making of *Bidis* which are growing in popularity among the masses.

CHAPTER 23

FIBRES

In this chapter we shall be concerned with plant fibres which are the sources of clothing and other woven goods, cordage, and a wide variety of lesser materials. The list of such fibres is long, and we shall limit our description only to cotton, jute and flax.

COTTON

Cotton is outstanding among vegetable, animal and synthetic fibres, accounting for approximately one half of all materials (measured by weight) that are made into cloth. Unlike wool or silk it has a large market both for clothing and for industrial uses.

Nearly 50 percent of world production goes into cloth and another 25 percent into carpets, curtains, and other household materials. The remainder is used chiefly for industrial purposes, both as a textile and as stuffiing, bathing, etc.

Ecological Requirements for Cotton

The influence of rainfall and the amount as well as the season when it comes, is of vital importance in the cultivation of cotton. Moderate to light rainfall is adequate for cotton cultivation. Between 50 and 100 cms are needed if the crop is to be naturally watered, but it has been found that better crops and better quality fibres can be obtained in semi arid and even arid conditions, with the help of irrigation.

The soil is the dominant factor in the cultivation of cotton. Medium loams with good drainage, which give the plant good support in widy or stormy weather are ideal. The cotton plant requires a great deal of mineral nutriment and is very exhaustive of the soil so that rich black loamy soils, as those of Ukraine, Prairie and Deccan plateau are the best cotton growing regions of the world. Alluvium sandy soils, as those of the HwangHo in northern China and Indo-Ganga basin in India, or Nile of Africa, here climate is next important factor in the cultivation of cotton than soil. A long growing period of at least 200 frost free days is also necessary for the plant growth. Thus cotton is cultivated largely in the tropical and sub-tropical latitudes, between 30° north and 30°south of the equator as shown in Fig. 23·1.

Cotton does badly in wet condition. In the United States for instance, the cotton belt is limited in the south by the fall of more than 30 cms of rainfall in the late summer and autumn. A reference to the rainfall map will show that most of the cotton in India is

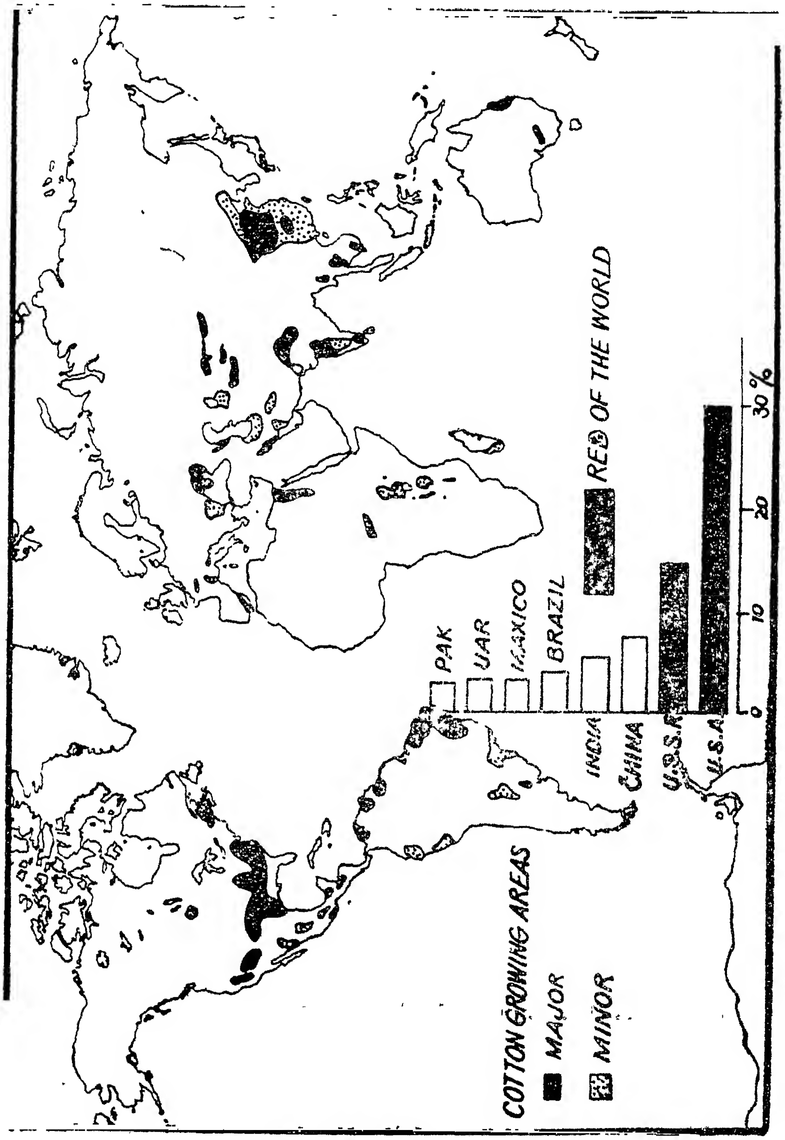


Fig. 23·1. Cotton Growing Areas of the World.

grown in areas which have a rainfall of 30 to 50 cms. per year. The picking season over the main cotton growing area, that is, from November to February, is practically dry. Few quotation clearly shows the ecological relationships of cotton yields in various parts of the world : "Lack of rainfall during the planting and early growing periods, combined with strong wind and sandstorms, led to a poor outlook for cotton production in the Matamoros, Mexico, this year. The chronic shortage of rainfall and water for irrigation will also tend to prevent any sizable increase in acreage in the coming season."[1] The effects of Indian monsoon on cotton growing is given in this way – "The lack of sufficient rainfall is the primary factor responsible for the low estimates this season (1951-52). The southeast monsoon ended earlier than normal and the northeast monsoon was delayed, both factors causing drought in parts of India.

Inadequate rainfall has also hampered the operation of the textile mills in Maharashtra state by contributing to a shortage of hydroelectric powers in that area. The government of that province has reduced the work week in the textile mills from 48 to 40 hours, effective November 1, 1951.

Ecological factors are also effect the variety of cotton as shown in this quotation. "Cotton in the remaining foreign countries (excluding China and the Soviet Union) is comprised almost entirely of American upland varieties. The production increase in these countries as a whole amounted to less than 400,000 bales despite an acreage increase of nearly 4,000,000 acres. The principal causes for poor yields were severe drought in Mexico, drought and heavy losses to insects (mostly caterpillars, in North Brazil, early drought followed by excessive rainfall and oilstorms in South Brazil, excessive rainfall in British East Africa, heavy insect damage and lack of insecticides, equipment, and experience in Syria, and losses from insects and plant diseases in Turkey."

Cotton is a crop which demands a very great amount of hand labour, and in order not to unduly enhance the cost of production, such labour needs to both abundant and cheap. Sowing which may last some weeks is followed by a long period of very careful cultivation to ensure the best results. Picking, which may begin in India as early as last week of December, is a long process which may be, and commonly is, spread over a period of about three months.

Cotton Varieties

The length to the fibre which develops in the cotton boll is an extremely important feature in subsequent manufacturing, because the longer staples form sturdier threads and hence are more highly prized. The longer the staple, the finer are the fibres. The common classification is :

Short staple cotton—The length of this type of cotton is 22

1. Foreign crops and markets, 1952

millimetres and grown mostly in Asia especially in India, China and south East Asia. This is very coarse and shortest type of staple so mostly used in carpet and hand from industries.

Medium Staple Cottons—The length of the staple varies from 22 m m. to 32 m.m. and mostly grown in the U. S. S. R. and U. S. A. The United States of America is the world's major producer of medium staple cotton.

Extra or Long Staple Cottons—The longest and finest of cottons, with a fibre length of more than 60 millimetres, are grown mostly in U. S. A. especially in Georgia and Florida, Egypt, and West Indies. Long staple cotton is also grown in Peru and Sudan. Egypt ranks first in long staple cotton. From long staple fibres many varieties such as *Sea island cotton*, *Tanguis*, *Sakel* and *Ashmouni* are developed. Sea island cotton which has smooth silky fibres as long as 65 m.m. is largely grown in West Indies.

Cotton Growing Areas

Cotton is grown between 30° North and 30° South of the Equator, but its cultivation is mostly concentrated in the river valleys (Nile), deltas and low-lying coastal areas of China, U.S A., and flat plains of Prairie and Indo-Ganga, etc.

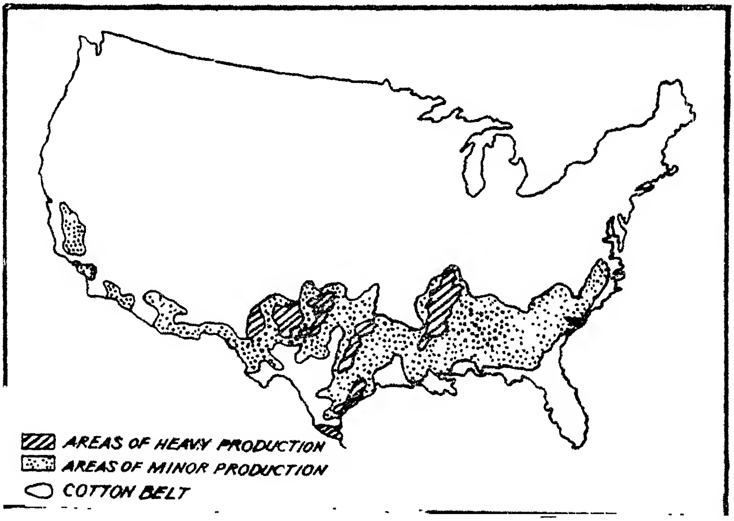


Fig 23·2 Old Cotton Belt of U. S. A.

U. S. A.

Cotton production in the United States is largely in an area once known as the cotton belt of North America. The term cotton belt has been applied to a large area from Southern Virginia to west Texas, including Oklahoma, Arkansas, Tennessee and Missouri estates as shown in fig. 23·2.

Texas is the outstanding producer, being responsible for over one fourth of the U. S. A's cotton. Heavy concentrations are found on the relatively moist Prairie and black soils near the state's eastern boundary, and on the drier brown steppe soils of the north west, where irrigation is necessary. The principal growing area is Carolina, the cotton belt which is 2560 kilometres east-west and 480 km. north south and embraces the states of S.W. Virginia, North Carolina, Georgia, Alabama, Tennessee, Mississippi, Arkansas, Louisiana, Oklahoma, Texas Southern tip of Indiana and south-eastern tip of Missouri. For over a century this has been the world's leading and most highly specialized cotton producing area.

The cotton of the Southern states is chiefly of medium staple size, whereas that of the arid west has a slightly longer. A small amount of extra long cotton fibre is also grown in Texas, Arizona, New Mexico and California. California produces nearly one seventh of the nations cotton, largely under irrigation on the alluvial and colluvial soils of upper and central San Joaquin River valley.

Changes in Cotton Belt Location

The twentieth century is bringing change to cotton growing areas in the southern states of United States. Several important changes have altered the entire economy of the old cotton belt. The most important has been the westward shift in cotton growing areas. In west ward the large mechanized farms are more economic than the small farms of the older eastern regions Cotton growing is now concentrated much farther west as shown in fig 23 3. This figure clearly shows that the most outstanding of these areas are in the black and red Prairie soils of Texas and Oklahoma, and the flood-plain of the lower Mississippi river bottom. The new cotton areas of the United States can be broadly divided into the following six

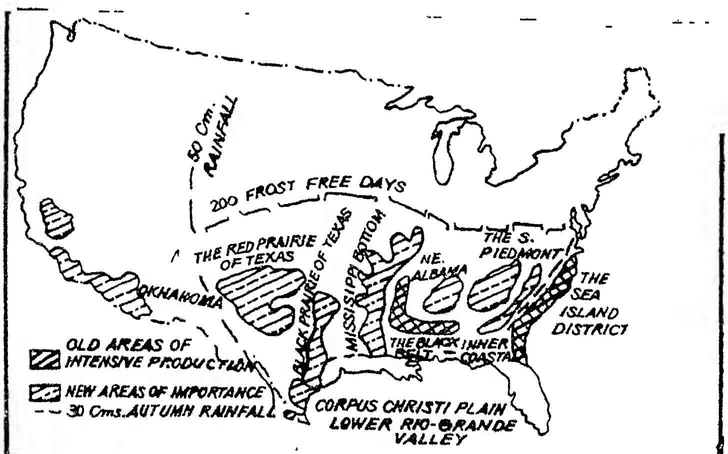


Fig. 23·3 Shifting of Cotton Belt in U S A.

regions according to the importance of cotton yields : (1) Southern Texas coastal plain, (2) North-west Texas and Oklahoma, (3) Mississippi flood plain, (4) Black Waxy Prairies, (5) Tennessee valley and (6) Atlantic coast and Piedmont region.

Locational changes within the United States during the past three decades have involved (1) a shift of the industry to focal districts in the Southern States and (2) an initiative of cotton growing in the western states especially in California and Arizona. In 1970, there were 4464 thousand hectares of cotton harvested in the United States, the average yield per ·4 hectare being 410 bales. In 1971, there were 4588 thousand hectares harvested at an average yield per ·4 hectare of 407 bales. The total harvested in 1972 was 5262 8 hectares and production was 13567 thousand bales. The U. S. A. ranks second after the U. S. S. R. in cotton production.

U. S. S. R.

About 90% of the Soviet Union's cotton is grown under irrigation in Soviet Central Asia. Only 10 percent of the Soviet's cotton is grown west of the Caspian sea in Azerbaijan and Armenia as

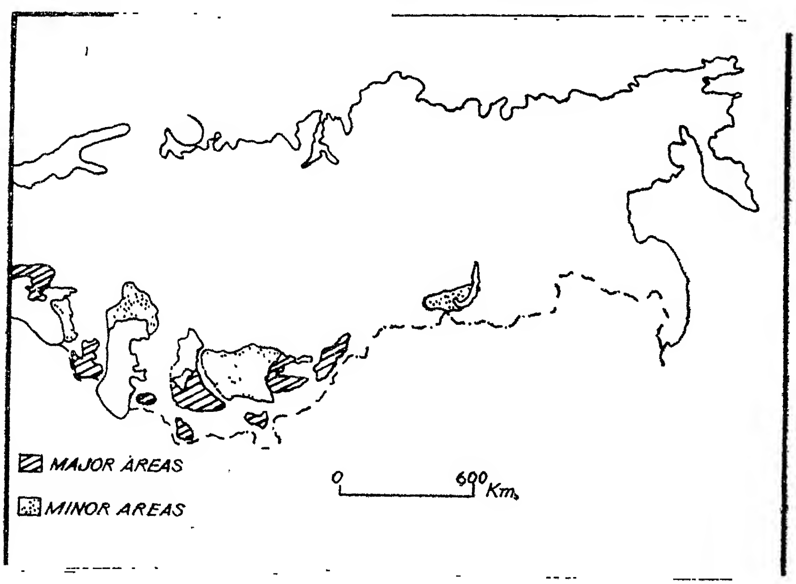


Fig. 23·4. Cotton Belt of the Soviet Union

shown in fig. 23·4. Although cotton has been grown for a long time within the present boundaries of the U.S.S.R. but the quality has been poor in the past. The first five year plan (1928) began expansion of cotton growing, which has encroached on the food-producing area of central Asia, where the most favoured areas are sheltered valleys with abundant water, plentiful sunshine and freedom from frost.

Uzbekistan, notably around Tashkent, Samarkhent and Fergana, has over half the sown area under cotton in the Soviet Union. In Tadzhikia, the Gissar and Vakhsh Valleys are known for long staples drawn from American and Egyptian varieties and policy now concentrates on quality rather than quantity, so that marginal producers in Northern Caucasia and the Ukraine have been reduced in area, but Azerbaydzhan is rising as a long staple cotton grower.

Azerbaijan has become an important cotton growing and sub-tropical base. About 70% of cultivated land is irrigated. On the irrigated land crops of Egyptian and sea-island varities cotton are obtained ; cotton is also grown in Nahichevan Autonomus Soviet Socialist Republic. Nearly 70% of the people are engaged in agriculture, of which the main branches are cotton and tobacco growing.

The main fibre of Turkmenistan is cotton. A considerable area is under Egyptian cotton, and from it has been evolved an original Soviet long-fibred cotton.

Uzbekistan is a land of intensive farming, based on artificial irrigation. It is the chief cotton-growing area in the U.S.S.R. and the third in the world. In 1939 the Ferghana canal was built. During 1940, among the irrigation canals completed were : the North Ferghana canal (165km) and Andreev South Ferghana canal (108km) and the first section of the Tashkent canal (163 km). A canal from the Amu-Darya to Bokhara across the Kzil-Kum and Ust-Urt deserts (180km) was completed in 1965. A 200 km. canal joining the river Zeravshan with the Kashka Darya at the village of Paruz was completed in Aug. 1955; it is part of the Eski Angara canal. The first section of a canal (93 km) irrigating the southern "Hungry steppe" was opened in 1960 ; 500,000 hectares of this desert were under cultivation in 1967.

Agriculture flourishes, particularly in the well-watered warm, rich oases areas, such as the Ferghana valley, Zeravshan, Tashkent and Khorezm, where cotton is mainly cultivated. More than 50% area under cotton cultivation. In 1972 there were 1,037 collective farms and 412 state farms, with 130,600 tractors and 27,400 cotton picking and grain combines ploughing, cotton sowing and cultivation are completely mechanized, cotton-picking over 46%.

Kirghizia and Kara Kalpak Republic are other important producers of cotton in the Soviet Union.

China

China ranks third in cotton production after U.S S R. and U.S.A. Cotton is China's chief fibre, and the country held third places in its production since to the second world war and its output of textiles is exceeded only by that of the U.S A. with its vast population, China has a vast domestic market for cheap cotton goods, and its low production costs, based on its large labour sup-

plies, enable to sell textile, abroad. At present the Great Plain of Northern China, along the Hwang Ho and Wei Ho valleys, Yangtze valley, Szechwan, Honan and Hopei are the leading producers. Much of the cotton fibre grown here has a short staple, grown under rather primitive conditions. About 5% of Communist China's arable land is now planted to cotton. Although some cotton is grown under irrigation in the arid west and north, no outstanding new growth areas have been opened up since the revolution. Much of northwest China is too dry for any cultivation unless especial sources of water are available. Irrigated crops include cotton,

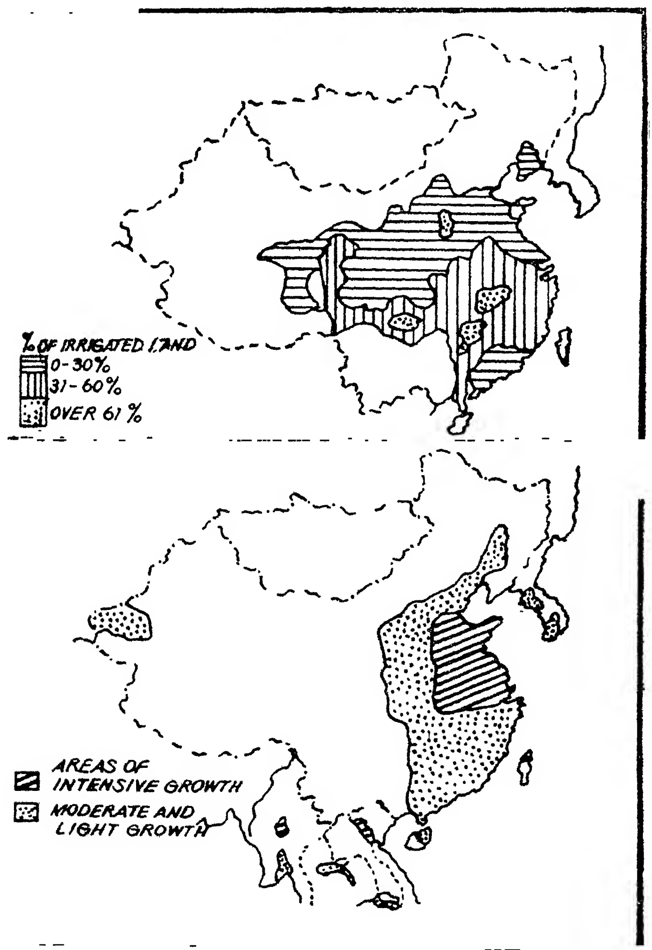


Fig. 23·5. Cotton Growing Areas in China

tobacco and vegetables. Fig 23·5 shows the percentage of irrigated land in China in relation to cotton areas. The climate of this

part of China is markedly uneven from year to year, with periodic drought, crop failures were not uncommon. Even then cotton output tripled between 1 49 and 1954 and more than doubled again by 1958. Since 1961 raw cotton production has increased steadily as the following output data show.

Table 23·1

Cotton Production in China

Year	Production in tons
1961	1,090,000
1965	1,200,000
1966	1,260,000
1967	1,300,000
1972	1,400,000

Cotton Growing Areas in India

The cotton areas in the country can be broadly grouped into the following three regions according to cotton growing season.

Central and Western Zone—This zone, which comprises western district of Madhya Pradesh, Maharashtra, Gujarat and some parts of Andhra Pradesh, has the highest intensity of cotton cultivation in the country. The main areas for cotton cultivation in Maharashtra and Gujarat are Ahmedabad, Broach, Surat, Dharwar, Khandesh etc. In Broach, the soil is deep and retentive to moisture. The Black cotton soil in some parts is about 1·5 metres deep. Over the greater part the annual rainfall exceeds 90 cms. The crop is sown as soon as possible after the monsoon sets in. It is grown alone, but where the rainfall is heavy and the soil retentive (as in Broach) rice is grown with it. The principal associated crop with cotton is, however Jowar The flowering begins in October-November and the picking generally starts in January, lasting till March or April. In Madhya Pradesh sowing of cotton commences with the rains in June. Picking starts in November and is finished by March.

South Eastern Zone—This area, comprising the deltic tracts of the Cauvery and non-deltaic rainfed areas of Tamil Nadu has two cotton growing seasons There are two forms of indigenous cotton usually grown in Tamil Nadu, are depending on the South-Monsoon, the other on the north east. The former crop is sown between May and July. and the latter between September and November. In Tirunelveli both are sown in the same season, October to November. In the Tamil country where cotton is produced both on black soil, and red soil, the crop is sown in black soil during the south-west monsoon when the rainfall is not heavy, and in the red soil, which is a lighter soil ; during the north east monsoon where he rainfall is heavy.

North Western Zone—This zone comprising Bihar, Uttar Pradesh, Panjab and Rajasthan, has low winter temperatures, and only crop of cotton can be grown from March-August to January-March.

Outside the peninsula irrigation plays an important part in cotton cultivation. Sowing of the crop does not, therefore, wait for the rains in the areas where irrigation facilities are available. In areas where such facilities are not presen t, however, the sowing can be done only with rains. The period of sowing thus varies from March to August In the Panjab, owing to the danger of frosts, the picking is completed by about January.

In Uttar Pradesh, too. cotton production is almost entirely dependent upon irrigation. In this state cotton is usually grown in rotation with wheat. In U.P. the most important districts producing cotton are Saharanpur, Muzaffarnagar, Meerut, Bijnor, Moradabad, Bulandshahar, Aligarh, Mathura, Agra, Mainpuri, Etah, Etawah, Kanpur, Rampur, Nainital bhabar, Bareilly etc.

Area and Production of Cotton in India

The total area under cotton in India is at present about 8 million hectares spread over a dozen states. The bulk of this area as much as 82% is rainfed while only 18% or 1 04 million hectares have irrigated. Though the per hectare output has gone up, it is much below the average of main cotton-producing countries of the world. The irrigated areas of cotton are spread over some 55 districts of the country. More than half of the area is located in a few sizable blocks in Panjab, Rajasthan, Haryana, Gujarat and Tamil Nadu.

As much as 25% of the total produce of cotton in the country is grown in Gujarat. It is also the highest producer of long-staple and extra long staple cotton now being cultivated in the country. The average area under cotton cultivation during 1970 71 was 7609 thousand hectares. The highest hectarage was recorded in 1964 65. With in the Indian Republic, Maharashtra stands out predominantly in hectarage followed by Gujarat, Karnataka, Madhya Pradesh, Tamil Nadu, Panjab, Rajasthan, U.P., Assam, Tripura as seen from table 23·2.

Table 23·2

Area under cotton in different states 1973–74.

State	Area in thousand hectares	Production thousand bales of 180 kgs. each
Andhra Pradesh	320·8	114·5
Assam	4·2	1·7
Bihar	4·0	20 4
Gujarat	1789·9	1383·2

Kerala	7 5	8·4
Madhya Pradesh	699·3	334·4
Tamil Nadu	296 9	351·9
Maharashtra	2531·0	1053·3
Karnataka	888·2	418·4
Orissa	0·4	0·6
Panjab	504 0	1016 0
Rajasthan	343 1	287·2
U.P.	50 4	41·0
Delhi	0 6	0·5
H P.	0·5	0 7
Haryana	265·0	442 0
Tripura	2 4	2·2
J. & K.	0 6	1·4
Pondicherry	1·5	4·8

The production of cotton in India during 1970 71 was 4555 thousand bales. Production of China during the same year was estimated at 10,000 thousand bales. India has fairly increased her overall cotton production in recent years, is evident from the following table.

Table 23·3

Cotton Production in India

Year	Figures in 000 bales of 180 kgs each
1970–71	4555
1972–73	5417
1973–74	5819

Since the beginning of the present century the home consumtion of raw cotton in India has been increasing. The average consumption of Indian cotton in Indian mills during the period from 1947-48 to 1955-56 was about 27 lakh bales. In 1972-73 this consumption was 141,6000 bales and 1336000 bales in 1973–74 The greater part of this consumption is of long and medium staple cotton.

Since the home production of cotton has not met the rising demand, imports have become a necessity which forms roughly 10 percent of the total consumption as seen in the table 23·4.

Table 23·4
Cotton consumption in India

Year	Imports 000 bales of 180 kgs each	Value in million Rs.	Consumption 000 bales		
			Indian	Foreign	Total
1970–71	910	1124·78	5657	714	6371
1971–72	850	1100·00	5073	846	5919
1972–73	939	N A.	1078	338	1416
1973–74	477	N A.	1115	221	1336

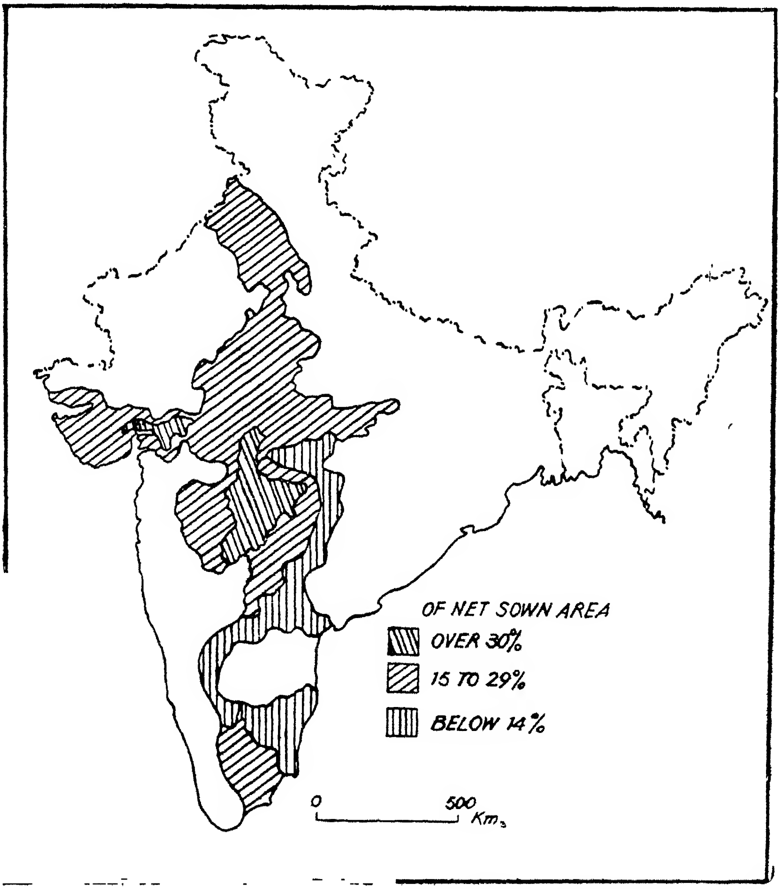


Fig. 23 6. Cotton Growing Areas of India

Brazil

In Brazil, the cotton crop is gaining in importance, and accounts for about two-thirds of the South American output. The crop is

grown in the states of SaoPaulo, Minas Gerais and Espirito Santo, Northeast. Conditions are excellent for cotton growing as the wide range of climate enables cotton cultivation from all the intermediate zones between temperate and Tropical to be cultivated successfully.

Other nations—of the many countries producing cotton, the leading four (U S S.R , U.S.A., China and India) account for about two-thirds of the world's output. These are followed by Brazil, Mexico, the United Arab Republic, Pakistan and Turkey. Cotton, now from Mexico accounts for about one fifth of the countrys exports and is the leading export commodity.

The main areas for cotton cultivation in Pakistan are Montgomery. Lyallpur, Multan, Lahore, Muzaffargarh and Sukkur. Cotton cultivation is down by the help of irrigation. The cotton of Pakistan is predominantly short and long staple varieties grown under irrigation in scattered districts in north west Frontier provinces.

Peru, Turkey, Sudan, Argentina, Syria, Uganda, Congo, Nigeria Spain, Iran etc. are other important producers of cotton in th world.

Production of cotton

Although the cotton manufacturing industry has traditionally been dominated by the U.K but the United States leads in cotton textile production since world war II, the rapid expansion of cotton growing in both the U.S.S.R. and China has ended its dominance in fibre production. The production of cotton in 1972 was 130 lakh metric tons of which U.S S.R. produced 24 lakh metric tons. Production of China during the same year was estimated at 14 lakh metric tons, 15 percent of the world's cotton production and second highest in the continent of Asia. India which had the higher hectarage, accounted for 11% of the world production.

The U.S.S.R. now accounts for about 20% of world's cotton production and the U.S.A. 16%, Mexico 5%. Pakistan 5%. The other important cotton producing countries are Brazil, Peru, Turkey, Sudan, Egypt, Uganda, Syria, Iran, Spain, Greece etc., jointly accounted only 18% of the world output.

The following table 23·5 gives the production of cotton (lint, of selected countries of the world.

Table 23 5

Cotton Production (Production in lakh m. tons)*

Region/Country	1962	1972
World	107[1]	130[2]
Central & N. America	36·6	36
U. S. A.	31	30
Mexico	4·6	4

* U N. Stat year book 1973. 1. excluding China, 2 including China

Nicaragua	0·3	1
U.S.S.R.	14·6	24
Asia	17·9[1]	43[2]
China	34·1	14
India	10·1	11
Pakistan	3·0	7
Turkey	1·8	5
Syria	1·1	2
Iran	1 0	2
Africa	9·2	14
Egypt	4·8	5
Sudan	1·2	2
S. America	8·8	10
Brazil	5·4	7
Colombia	0·7	1
Peru	1·3	0 8
Argentina	1·2	1
Europe	1·7	1
Spain	0·7	1
Greece	0 6	—

Trade of Cotton

Although the United States is the world's leading producer of cotton, it also buys some cotton. The United States does not grow the rough, white short staple cotton used for manufacturing cotton and mixed cotton wool blankets. The United States has declined relatively as a supplier of cotton, and non-communist, less developed countries have risen by nearly the same amount as seen in table 23 6.

Table 23·6

Changing Pattern of World Cotton Trade, 1957–66.*

Exporting Area	1957–61 Average % of the world total	1966 % of world total
United States	38·4	26 0
Other non-Communist, technically advanced countries	3·1	5 1
Non-Communist developing countries	47 1	57 6
Communist countries	11 4	11·3

* AO Commodity Review, 1966.

During the beginning of present decade two important trends occurred in world cotton trade. The first was a slight decline in exports in U.S.A., Peru, Uganda etc. The trend is importantly a result of competition between cotton and man-made fibres, which are in rising demand. The second trend is that developing countries gaining importance in international market. India and China are leading exporters of cotton in international markets. This pattern is summarised in table 23 7.

Table 23·7

Export of Cotton in selected Countries
(Figures in thousand tons)*

Country	1970–71	1971–72
U.S.A.	848	737
U.S.S.R.	607	628
Brazil	220	282
Egypt	304	304
Mexico	164	209
Turkey	234	325
Sudan	228	217
Syria	134	130
Iran	107	78
Pakistan	102	233
Peru	59	54
Uganda	68	59
Greece	72	74
Tanganyika	66	41
India	30	39
World	3877	4026
Socialist Countries	607	629

CONSUMPTION OF COTTON

A recent survey conducted by the Textiles Committee regarding the consumption of cotton for various end uses provides useful data for tailoring the production of textiles and textile raw materials to the requirements of the market. The study, which was carried out under a cooperative agreement with the Cotton Council International of America, analyses in detail the production of various categories of cotton goods for the years 1971, 1972, 1973 and 1974, indicates the trend in the consumption of cotton for various end uses and indicates the extent of competition which cotton has to face from rayon and Synthetics. The following table 23·8 shows the consumption of important fibres of the world.

* Kothari's Handbook, 1973–74.

Table 23·8
Consumption of Various Fibres since 1964 to 1974

	Average 1964–66	Average 1967–69	1970	1971	1972	1973	1974
Total Consumption thousand tons							
Cotton	10918	11440	11862	12289	12727	13038	12816
Woollen	1569	1637	1666	1640	1713	1608	1424
Flax	694	727	753	752	718	707	703
Silk	34	36	38	37	43	44	42
Synthetic fibres	3397	3458	3454	3484	3594	3699	3485
Viscose yarn	2195	3628	4842	5790	6576	7811	7630
World consumption of Total fibres	18807	20926	22615	23992	25371	26907	26100
World Population (in millions)	336·3	347·7	361·7	368·5	375·8	383·1	390·5
Per capita consumption (kg.)							
Cotton	3·2	3·3	3·3	3·3	3·4	3·4	3·3
Wool	0·5	0·5	0·5	0·4	0·4	0·4	0·4
Silk	—	—	—	—	—	—	—
Synthetic	1·0	1·0	1·0	1·0	1·0	1·0	0·9
Viscose yarn	0·7	1·0	1·3	1·6	1·7	2·1	1·9
All fibres	5·6	6·0	6·3	6·5	6·7	7·1	6·7
% of consumption of natural fibres	70	66	63	61	60	57	58
% of man-made fibres	30	34	37	39	40	43	42

The study reveals that the consumption of cotton has not kept pace with the total production of cloth of all types, that is, wearable cloth, household goods like sheeting, typestry, furnishings, bed sheets, ticking cloth, mosquito netting cloth, tablecloth etc. The difference is accounted for by the increased use of man-made fibres for apparel and household uses. While production of cloth, including rayon and synthetic fabrics, for the domestic market had increased by 22 percent during 1959 to 1967, the consumption of cotton for production of cloth intended for the domestic market shows an increase of 20·4 percent.

The overall consumption of cotton for all purposes, by the cotton textile industry, including handloom and powerloom sector and production for export increased from 5096 thousand bales of 180 kg. each in 1959 to 5834 thousand bales in 1963, but dropped to 5800 thousand bales in 1963. Taking only goods meant for the home market, cotton consumption increased by 21 percent in 1967 as compared to 1959.

The production of different categories of cotton goods and the estimated consumption of cotton for each type of end use during the three years covered by the study are shown in the table 23·9.

Cloth for the apparel market accounts for the bulk of the cotton consumed by the textile industry. Cotton consumed for production of wearable cloth in 1959 amounted to 3600 bales (84 percent) in 1959, 4138 thousand bales (79·8 percent) in 1963 and 4219 thousand bales (79·9 percent) in 1967. Production of household goods accounted for 10·7 percent of total consumption in 1959, 13·6 percent in 1963 and 12 8 percent in 1967. The figures for other categories for the three years are : Hosiery 1·9 percent, 2 7 percent, and 3 2 percent, Miscellaneous goods 1·5 percent, 1·4 percent and 1·5 percent, and industrial goods 1·9 percent, 2·5 percent and 2·6 percent

While the overall consumption of cotton has increased by 23·2 percent over the period 1959 to 1967, the increase was not evently distributed. For instance, cotton consumed for wearable items has increased only by 17 percent from 3600 thousand bales to 4219 thousand bales, while in the case of other items combined, the increase is 55 percent over 1959.

The production of wearable varieties of cloth increased by 16·1 percent in 1967 over 1959, but same categories of man made fibres as Textiles increased by 43 8 percent over the same period. The share of rayon and synthetic fabrics in total production of wearable textiles for the home market had increased from 8·1 percent in 1959 to 8·5 percent in 1963 and to 9 9 percent in 1967.

The share of rayon and synthetic fabrics in the domestic market for household goods has increased from 39% in 1971 to 42% in 1974, there is a corresponding decline in the share of the same categories of cotton fabrics, as shown in table 23·8. The consumption of cotton for the production of household textiles increased

Table 23 9

Cotton Consumption and Production of Textile goods for Home Market

End use	Units	1959	1962	1967	Percentage increase over 1959 in 1963	Percentage increase over 1959 in 1967
I. Wearable cloth						
a. Total production	Million metres	5819	6629	6885	13·9	12·3
(of which man-made fibres)	,,	(474)	(560)	(681)	(18)	(43·8)
b. Cotton cloth	,,	5345	6069	6204	13·5	16·1
c. Cotton consumption	000 bales	3600	4138	4219	14·9	17·2
A. Men's wear						
a. Total Production	Million metres	3007	3631	4096	20·7	36·2
(of which man-made fibres)	,,	(15)	(103)	(198)	(587)	(1220)
b. Cotton cloth	,,	2992	3528	3898	14·6	30·3
c. Cotton Consumption	000 bales	1992	2393	2632	20·1	82·1
B. Women's wear						
a. Total Production	Million metres	2812	2998	2789	6·6	(—)0·8
(of which man made fibres)	,,	(459)	(457)	(483)	(—)	5·2
b. Cotton cloth	,,	2353	2541	2306	7·9	(—)2·0
c. Cotton consumption	000 bales	1608	1745	1587	8·5	(—)1·3
II. Household Goods						
a. Total Production	Million metres	493	709	818	43·9	66

(of which man-made fibres)	”	(5)	(14)	(174)	—	—
b. Cotton cloth	”	488	695	644	42·4	34
c. Cotton consumption	000 bales	462	707	674	53	45·7
III. Hosiery						
a. Production	Million kg.	13·6	22·7	27·6	67	103
b. Cotton consumption	000 bales	80	140	170	66·6	112·5
IV. Miscellaneous Goods						
Cotton consumption	000 bales	60	70	77	21·7	28·3
V. Industrial Goods						
Cotton consumption	000 bales	83	130	140	56·0	68·7
Total cotton consumption	000 bales	4285	5185	5280	21	23·2

Data from various sources.

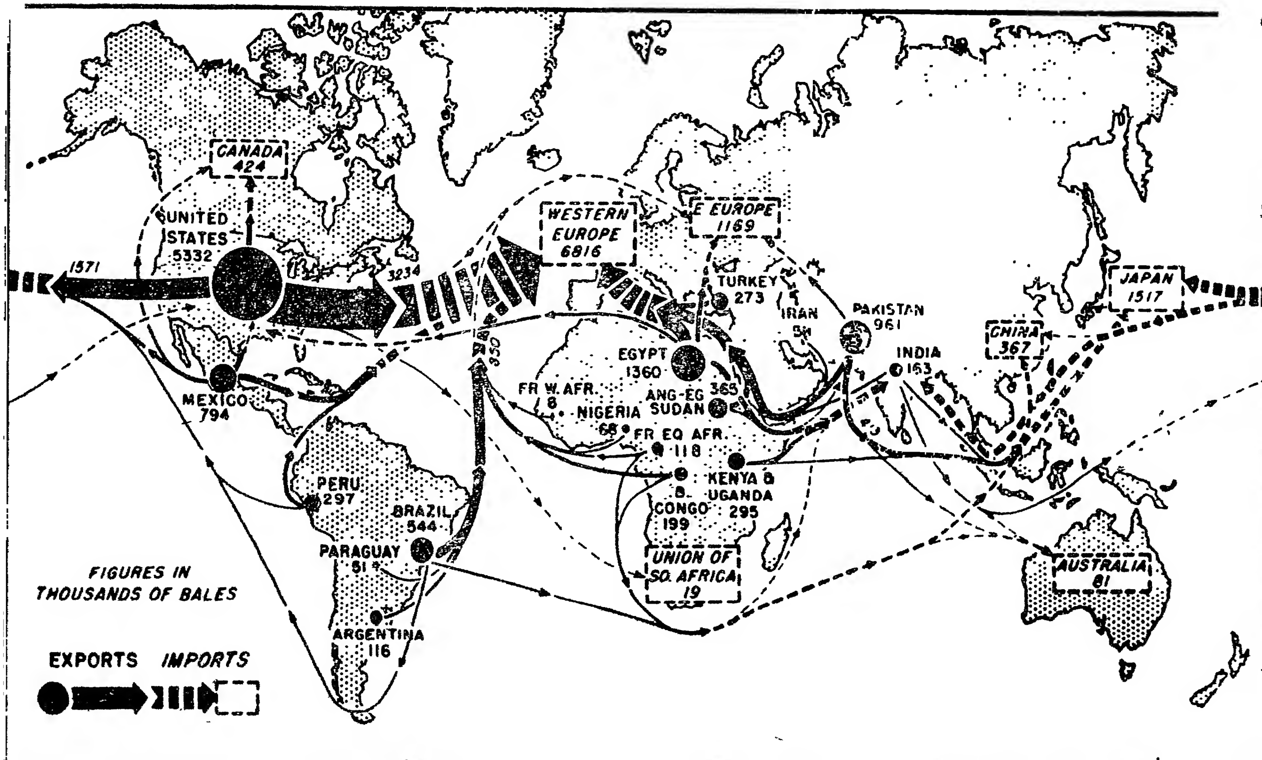


Fig. 23·7. Cotton Trade

by 45·7 percent in 1974 over 1971, while in terms of production the increase is about 32 percent. The difference in the two is attributed to the changing Pattern of production.

JUTE

Cultivation of Jute was prevalent in the Indo Pak sub-continent even during the pre-historic period. The famous ancient Hindu writer, Manu, mentions "*Patta*" a fibre of jute type, in one of his books which traces back its cultivation in the Ganga delta in 800 B.C. It is said that the leaves of the plant were used at that time as food and medicine. The great historian of the Mughal period, Abul Fazal, had also referred to it in his famous book *Aine-e-Akbari*, wherein jute prices and the revenues derived from it are mentioned.

In spite of its long history, jute cultivation did not develop much until the beginning of the 19th century. The fibre was first spun into year in England in 1820 in Oxfordshire. Before that, hand woven goods were manufactured in certain parts of Bengal.

In the earlier stages, jute was spun into yarn to make cordage which was used for agricultural purposes and paper making. The next stage was the preparation of rough fabrics for domestic uses, such as matting, bedding etc. Large-scale commercial exploitation of the fibre started much later and when this happened, it assumed unique importance as an industrial raw material. The jute industries first produced only coarse bags but later on experiements enabled them to produce finer qualities of material called hessian. The bleaching and water proofing of the fabrics made it possible to manufacture tarpaulins and canvas. The technique of mixing jute yarn with cotton, wool, silk, flax and other fibres led to the manufacture of curtains, upholstery, and coating fabrics, buck ram, packsheets, brattice-cloth, linoleum yarns, cords, rugs and carpets. There is still a great scope for further research to develop other uses of jute.

Ecological Conditions

Jute is generally grown on raised ground provided by the old or new river levels. In the depressions rice and jute are often rotated. The best quality of jute is obtained from loamy soils. Clayey soils give the heaviest yield, but the plants grown in such soil do not set uniformly. Sandy soils, on the other hand, produce coarse fibre.

In Bengal there are old and new alluvium soils which are called *lal mati* or *khiar* and *pilimati* respectively, the same as *Bhangar* and *Khadar* of Bihar and U.P. The new alluvium is generally found near large rivers, especially in their deltas and is commonly called alluvial soil *par excellence*. The soils of parts of Orissa, South Eastern Bihar and Burdwan division belong to old alluvium. The whole of north Bihar, west Bengal and north Bengal cossists of new alluvium, with the exception of Madhupur and the *Khiar* in North Bengal. Jute grows on new alluvium but not on

the old. *Khiar* land becomes very hard in a drought and prevents the spread of the roots of the jute plant. This seems to be the chief reason why it is so unsuitable for this crop.

Jute grows to perfection on loamy soil. The rain water sinks quickly into loamy soil ; hence loamy soil is preferred to stiff clay, which can neither absorb nor part with its water as readily as loam or sandy loam does. On clayey soil it yields a fibre which is sticky, more or less, while a coarse fibre is obtained from sandy lands. Jute is very badly affected by water logging when it is young.

It is well known that when a soil contains soluble salts in quantities above a certain amount, it is unfit for any crop. Even saltpetre, if present in the soil water in a too concentrated form, acts as poison for plants. Jute grows on the high lands as well as on the low lands which are not liable to submersion before the middle of June. Floods cannot do much harm to the plants once they are sufficiently strong that is, when they will shortly run to flower. Of course, highland jute is always superior to lowland jute in quality.

Climatic conditions are, however, of more value to jute than the composition of the soil. A hot damp climate in which there is not too much actual rain, especially in the early part of the season, seems to be best for it.

Jute is a rainy season crop. Damp heat is the most favourable for its growth. Excessive rain, saturating the soil with moisture, delays both sowing of the seed and the after treatments.

From two to four cms. of rain distributed in a month, during sowing period, may be considered sufficient. Occasional showers of rain, varying from two to four cms. at intervals of about a week, are most beneficial for the growth of the plants.

The temperature of atmosphere on the tracts where jute is grown hardly exceeds, during the growing season, 37°C and falls below 15°C. Humidity varies from 69 to 91. It is not possible to grow jute anywhere in Bengal during the cold weather.

The table 23·10 shows the normal maximum and minimum temperature of the air, the mean humidity and the normal rainfalls recorded at some typical stations in the jute growing areas.

Table 23·10

Meteorological Observation in Jute Growing Areas.

Month	Weather Conditions	Stations			
		Calcutta	Dinajpur	Gauhati	Silchar
March	Min. temperature C.	14	9	12	13
	Max. ,, C.	40	36	40	36
	Humidity %	80	65	75	80
	Rainfall cm.	5·5	5·4	12·5	60

April	Min. Temp. C.	21	18	19	16
	Max. Temp. C.	40	38	32	33
	Humidity %	79	81	84	87
	Rainfall cm.	12·5	12·5	45	94
May	Min. Temp. C.	21	19	18	19
	Max. Temp. C.	40	42	35	36
	Humidity %	81	72	81	85
	Rainfall cm.	45	43	55	94
June	Min. Temp. C.	24	21	2	22
	Max. Temp. C.	36	35	35	27
	Humidity %	87	88	82	88
	Rainfall cm.	67	115	94	125
July	Min. Temp. C.	23	21	22	22
	Max. Temp. C.	35	35	35	38
	Humidity %	89	91	83	91
	Rainfall cm.	82	94	75	124
Aug.	Min. Temp. C.	23	23	24	19
	Max. Temp. C.	32	33	35	36
	Humidity %	89	91	86	91
	Rainfall cm.	75	82	55	126
Sept.	Min. Temp. C.	23	23	23	22
	Max. Temp. C.	33	33	33	34
	Humidity %	90	89	83	90
	Rainfall cm.	65	75	43	82

The maximum temperature of water in which jute is steeped should be about 26°C. The rainfalls appear to be too heavy in Silchar for the jute crop.

The districts of Ganga delta which have a heavy annual deposit of silt have a superiority over others which have little or no silt deposit, especially because manuring is not commonly practised in jute cultivation.

Jute Growing Areas

The Indo-Pak sub-continent produces most of the world's jute. It is grown in small quality in Formosa (Taiwan), Brazil, Argentina, Japan, China, West Africa, Egypt, Sudan, France, Turkey, Thailand, Burma, Indonesia, Paraguay, Mexico and the U.S.S.R. Fig 23·8 shows the jute growing areas of the world.

Jute growing areas in India

India had a world monopoly of jute before partition. It must be remembered that the largest consumption of jute is for packing material. Cheapness, durability and strength are not found in any other packing material as in jute. To increase the supply of raw jute in India the area under jute is increased.

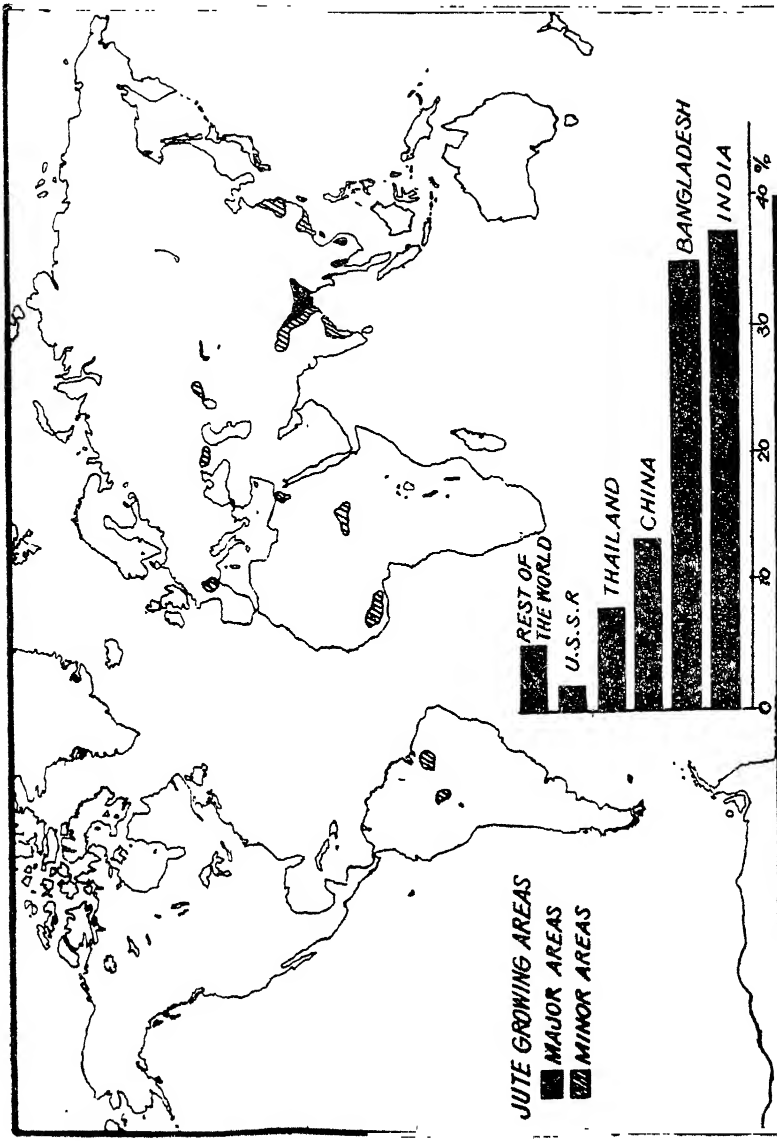


Fig. 23·8. Jute Areas of the World.

The main areas of jute cultivation in India are in west Bengal, Assam, Bihar, Orissa, Uttar Pradesh and Tripura. At present, jute is extensively cultivated in the districts of Golpara, Kamrup, Darrang, Nowgone, Garo hills and Sibsagar etc.

In West Bengal most important districts producing jute are Murshidabad, West Dinajpur, Cooch Bihar, Nadia, Malda, Burdwan, Midnapore and Twenty four parganas. In Bihar the important jute producing districts are Purnea, Saharsa, Darbhanga and Muzaffarpur. Some jute is also grown in Bhagalpur and Monghyr districts. Jute is very widely grown in coastal districts of Orissa. There are, however, small areas of jute cultivation spread all over the Terai region of Northern India. Jute is also grown in Kerala on experimental basis, because its climate and soil is ideally suited for jute cultivation.

In order to improve the quality of jute the Government envisages the setting up of 18 state farms for the production of good quality seeds, of which 13 are to be in Bengal, 3 in Bihar and one each in U.P. and Orissa.

In view of the dearth all over the jute growing states of retting water which constitutes singly the most important factor in influencing the quality of jute fibre, the government of India has accepted the three year scheme for constructing 8200 new tanks and re-excavating 4300 old tanks.

Area under jute cultivation in India

Total area under jute cultivation in the Indian Republic is 706000 hectares. Jute has the largest area in Bengal, about 52 6%, followed by Bihar 22·1%, Assam 15·5%, Orissa 6·2%, Uttar Pradesh 2·2% and Tripura 1·4%. The following table 23·11 shows the area under cultivation in different states of India.

Table 23·11

Production of jute and Mesta in different states of India
(Figures in thousand tonnes and hectares)

State	Jute		Mesta	
	Area	Production	Area	Production
Andhra Pradesh	N.A.	N.A.	91·3	405 8
Assam & Meghalaya	134·4	1010·1	8·3	31·7
Bihar	181·0	687·5	31 4	149·1
Karnataka	N.A.	N.A.	11·1	6·2
Orissa	41 6	223·5	31·9	184·7
U.P.	20·8	126·5	65·2*	384·3*
Bengal	432·3	2712·3	47·9	234 2
Tripura	12·0	9 5*	10·0	57 0

* Figs. for 1970-71.

In 1950-51 the production of jute in India was 33,09,000 bales. The highest production was recorded in 1955–56 when it reached a peak of 42,32,000 bales. The year 1972-73 saw a further increase in production reaching a new height of 56,84,000 bales

The total area under jute during 1972–73 was 815,000 hectares and in 1973–74 it was 706,000 hectares and the production was 5684000 and 4869000 bales each of 180 kg. during the same period.

Jute in Bangladesh

Bangladesh is an important jute producing country. The ecological conditions under which the crop is grown in Bangladesh vary widely. Cultivation methods differ, crop practices are also diverse. A large number of varieties of jute are, therefore, grown in different districts.

The best districts for jute Mymensingh, Decca, Rangpur, Bogra and Pabna all bordering on the Brahmaputra and affected by its floods, which deposit large quantities of fertile silt, now form part of Bangladesh. The old Brahmaputra or the Jamuna in Bangladesh also provides clearer water for retting the jute than the Ganga. The cultivation of jute decreases towards the south in the Ganga delta where the land is too low for jute, and towards the west where the rocky ground of the Deccan plateau is more marked than the Ganga alluvium.

Between 1947 48 and 1959-60, the area decreased from 822,700 to 550,000 hectares, although it recovered to 607200 hectares in 1960-61; showing a decline of 33 and 26% respectively; while the yield during the same period decreased from 1,222,000 tons to 992,000 tons and 1,005,000 tons, showing a fall of 19 and 18 percent respectively. The five year average of the area under cultivation during 1950–51 and 1954 55 was 608400 hectares. During the next five years it further declined to 466,400 hectares. These facts reveal declining trends both in area and yield over the last decade.

Bangladesh produces about 50% of the world production of raw jute; raw jute earnings for 1972-73 (estimate), 1904 m. *takas* nearly £ 60 million.

India now accounts for slightly less than one-half the world's jute output, and Bangladesh much of the remainder. Brazil, Taiwan, Nepal, Burma and Communist China are all minor producers. Communist China has been increasing its output and area in recent years.

Trade of Jute

Jute is also exported in its raw state and manufactured in Britain, Europe and the U.S A. Manufactured goods of jute are also exported from India and Bangladesh. Bangladesh is the outstanding exporting nation for raw jute About 60 percent of the nations annual harvest is shipped overseas, principally to north-western European countries 25% of jute is consumed at home

while 15% crosses the border into India, carried by small boots and streamers.

India also exports some jute and jute products. For the year 1970-71 India exported a sizable amount of jute manufactures to various countries of the world and earned foreign exchange to the tune of 1850 million rupees. Main in porters were U.S.A., Canada, United Kingdom, Argentina, U.S.S.R,, Egypt, Australia etc. who have preference for the Indian jute. Following is the percentage of jute exports—

U.S.A.	36·6%
Canada	5·5%
U.K.	13·7%
Argentina	3·3%
U.S.S.R.	29·9%
Middle East	2·1%
Egypt	1·5%
Australia	1·4%
Others	13·0%

The following table 23·12 shows the exports of jute sin-e 1970-71 from India.

Table 23·12
Export of Jute

year	000 tons	Value (million of rupees)
1970-71	29	109·5
1971-72	37	160·6
1972-73	28	138·3
1973-74	28	128·0

The average home consumption of India during 1970-71 was about 46·4 lakh bales. In recent years the average consumption of jute mills has been 502,000 bales as against the target of 840,000 bales.

FLAX

Flax is a plant of the cool temperate latitudes which has been used to make fibre and cloth from prehistoric times. Flax is grown for the sake of its fibre, which is used for making linen in North Russia, Poland and Baltic states, France and Belgium. Fig. 23·9 shows the flax producing countries of the world. The flax grown in Argentina, India, and other warmer countries is chiefly valuable for the oil obtained from the seed, which is called linseed.

Flax will grow on a wide range of soils and in cool, moist summers, but it rapidly exhausts the soil and is thus grown in rotations with fodder crops. Flax grown for fibre does best in

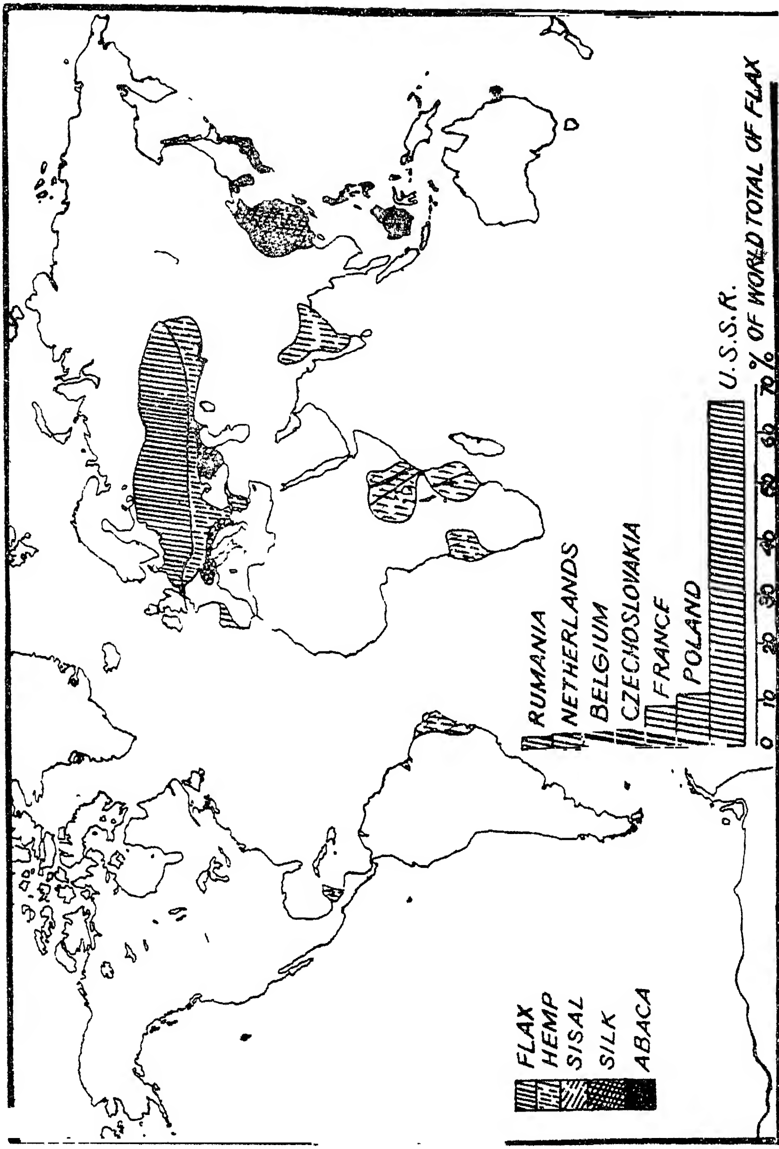


Fig. 23.9. World Distribution of major fibres.

rather cool, temperate conditions. Summer temperatures should be around 16°C to 18°C and a great range of temperature is not ideal for flax growth. Moderate rainfall (510 mm. to 700 mm.) and plenty of humidity in the atmosphere is essential for flax cultivation.

World Production and Trade

The Soviet Union is the world's largest flax producing nation of the world. Prior to world war II the U.S.S.R. produced about 70% of the world's flax, an average of 560,000 tons coming from the northern fringe of the agricultural area in central and western European Russia. The Soviet Union alone accounts for over three-fifths of the world's output of flax grown for fibre, Europe for nearly all the remainder. The Soviet Union has both good geographical conditions and fairly cheap labour costs and has the added advantage of a large domestic market. Poland, the second largest producer (10% of the total) also grows flax in the north European plain, followed by France, Czechoslovakia, Belgium, the Netherlands and Rumania.

Northern Ireland is a traditional linen manufacturing area of the world. The linen industry has become established in most of the large towns of North-East Ireland. This industry owes much of its prosperity to the fact that the water and climate here are so suitable for bleaching—i e. for rendering the linen white Some of the flax required is grown in North Ireland, but most is imported from Russia and Belgium. Coal too, has to be imported, for only a very little is found in Antrim and west of Longh Neagh, but it can be easily brought from the fields of Scotland, Cumberland and Lancashire. Belfast has become the centre of the linen industry and exports a great deal of linen to Liverpool.

HEMP

This plant yields a fibre similar to flax, but coarser and stronger. Hemp is closely related to flax and grows under similar conditions. It is used for making ropes and canvas. It is grown for this purpose in Russia and Italy. The hemp grown in India is chiefly used to make a stimulating drink. *Manila hemp* is obtained from the long leaves of a tree grown in the Philippines. It is now largely used for ropes as well as henequen, or *sisal* hemp, which is grown in Yucatan and the West Indies. *Phormium*, or New Zealand flax, is more adapted to use as hemp than as flax.

Hemp is grown in European Russia for both fibre and seed. The leading producers of hemps are the U.S.S.R. (29% of the world total) followed by India 22%, Yugoslavia 12%, Hungary 7%, Rumania 6%, Poland 6%, Pakistan 4 percent, and Bulgaria 3 percent. Prior to world war II, Italy produces the highest-priced hemp fibre, which is imported into Great Britain, Germany and the United States for commercial twine, coarse toweling, and carpet yarns.

SISAL

There are a large number of other fibres, just like Sisal, henequen. Abaca, mostly used in the production of ropes. Abaca is a very hard, resistant fibre which does not decay in sea-water and is therefore useful for marine ropes. Africa is the leading producer of sisal. It is a spiky-leaved shrubs, which grows in dry and seasonally-dry tropical climates. The fibre is used for coarse twine and matting. It is also used for bags, floor covering, bristles, and upholstry tow.

More than half the world crop comes from Tanganyika and Kenya where sisal is the leading commercial crop. The leading producers of sisal and henequen are the Tanganyika (28% of the world output) followed by Brazil 23%, Angola and Kenya 7% each, Mozambique and Malagasy 4% each, Haiti, Mexico and Venezuela 2% each, Taiwan and Cuba 1% each. Total world production is about 792,200 tons.

ABACA

Abaca needs fertile soil, moist climate and the plant is easily demaged by wind. The eastern and southern Philippine islands is the major producing area favoured by climate and fertile volcanic soils. Abaca or mainla hemp, is still a monopoly of the philippines and is one of the largest export crops. The crop has long been grown in thousands of small, primitively cultivated fields in the foothill area of Southern Luzon, the Eastern Visayan islands and in Northern Mindanao. Abaca crop is also grown in large and efficiently operated plantations in and around Davao and Mindanao. Malaysia ranks second and Coast Rica third. Total world production of Abaca is only 85,600 tons of which Philippines produces about 81,000 tons annually or 95 percent of the world total. Malaysia (Sabah) and Costa Rica, accounting for only 5 percent of the total world output.

SILK

Silk is an ancient product of old world, but its expansion is unlikely in face of competition from Synthetic fibres, but still a luxury for fashionables ladies.

Silk is derived from silkworms which feed on mulberry leaves. Silkworms are reared in some countries where mulberry-trees can be successfully grown, on the leaves of which they feed. The large supply of cheap skilled labour required, however, limits the areas of supply. The chief silk-producing countries are China, Japan and Italy.

Silk in China

China is the true home of silk. The mulberry trees are cultivated and silkworms feed on its leaves. Much of the silk is made up into fancy materials of good quality in the homes of tke towns people. The towns of Turkestan were old and famous in the days of Marco Polo, the Venetian traveller who journeyed all the way

to China through the old Silk route of Asia. Samarqand, Kashgar, Yarkand etc. are all situated on old silk route of old world and these are the famous silken town of that days.

Silk in China is best produced in the Yangtze Delta but also grown in Szechwan and Kwangtung. Shantung pongee silk comes from worms which are fed on oak leaves. Chinese silk ranks with the best, but China lost her one time monopoly of the market through failure of standardize and improve methods.

Silk in Japan

Owing to the mountainous nature of the country not more than one-sixth of its area is available for cultivation Mulberry trees are now cultivated on only 163000 hectares (about one-third of the pre-war area) and silk is playing a reduced part in Japanese exports.

A quater of all Japan's silk produced on the Kwanto or Tokyo plain, with even larger amounts in the near by mountains. In some uplands districts from 30 to 50 percent of the cultivated land was in mulberry. When the silk market declined in the late 1930's, some of this mulberry lands was turned to rice cultivation.

India

Assam is the largest producer of Silk in India. *Assam silk* is famous for *Sarees* etc. Tamil Nadu and Kashmir are others important producers of silk in India.

Italy

After China and Japan, Italy ranks third in silk production. Silk culture, while flourishing most extensively in Po or Lombardy, Piedmont, and Venezia, is carried on all over Italy. The silk industry, Dec. 1972 had 735,671 spindles and 21,935 looms ; output of raw silk in 1972 was 155 metric tons.

The dry summer of Mediterranean climate does not favour the mulberry, and so that silk production reached major proportions only upon the level, irrigated plains of northern Italy and to some extent in Rhone-Sone valley.

Other Countries

Other silk producing countries, some of them quite ancient, are to be found in the Levant, Turkey and Iran. Silk is an ancient product of Central Asia and Transcaucasian mountains of Russia.

International Trade of Silk

China, Japan and Korea are silk exporter countries of the world. But their real statistics are not available at present. Referring to the world demand for silk by 1980, according to the estimates made by the Food and Agriculture Organization the demand would go up to 48,601 tonnes. Since there was a marked decline in silk production in the developed countries (Japan had produced 43,153 tonnes of raw silk in 1948 and it came down to 20,819 tonnes in 1975). There was ample scope for India to

increase its production and consequently foreign exchange earning, by exporting raw silk.

China and South Korea are the two main competitors in the world market. According to FAO sources, China plans to increase its raw silk production from 10,200 tonnes in 1970 to 16000 tonnes by 1980. Likewise, production of South Korea would go up from 2846 tonnes in 1970 to 6500 tonnes by 1980.

Even if both countries succeed in increasing their production as per FAO estimates, there would be a substantial gap in world demand and production.

Foreign exchange earnings in India from Silk export are likely to go up from Rs. 7·47 crores in 1971-72 to Rs. 20 crores by the end of the fifth Five Year Plan with its production going up from 2,250 tonnes to 3,850 tonnes by 1978-79.

The Central Silk Board and the Union Government of India to recommend schemes for silk development during the Fifth Plan had envisaged the possibility of investment of about Rs 25 crores to raise the production of mulberry and non-mulberry silk. Thus the Indian silk industry, if properly planned, could make a substantial contribution to increase the foreign exchange earning of the country.

WOOL

Wool is the premium natural animal fibre. Wool is a valuable fibre in the cooler temperate areas of the world from ancient time. Wool remains the mainstay of textile industry despite increased utilization of plant and man-made fibres.

Sheep can graze on pasture where cattle and horses would starve. Sheep are suited to grass lands in temperate regions, and do best in a rather drier climate than cattle. The chief wool producing countries are Australia, the U.S.S.R., New Zealand, Argentina, S. Africa, Uruguay, U.S.A., China, Turkey, the United Kingdom and India. Fig. 23 10 shows the wool producing countries of the world.

The *merino* breed of sheep, which yields the best wool, is poor in mutton. British sheep form good mutton, and so do many crossbreeds between English and *merino* sheep. New Zealand, Argentina and Australia are the chief mutton exporting regions, on account of their machinery for preserving meat.

Goats are common in Mediterranean countries, and the Angora goat of Asia Minor, which yields *mohair* has been introduced to South Africa. The wool of the Kashmir goat of India is also famous and known as *Cashmeeri* wool.

Australia

Australia is a leading wool prodcer nations of the world and has more sheep than any other country. Pastoral production and in particular sheep farming are of prime importance in the Common-

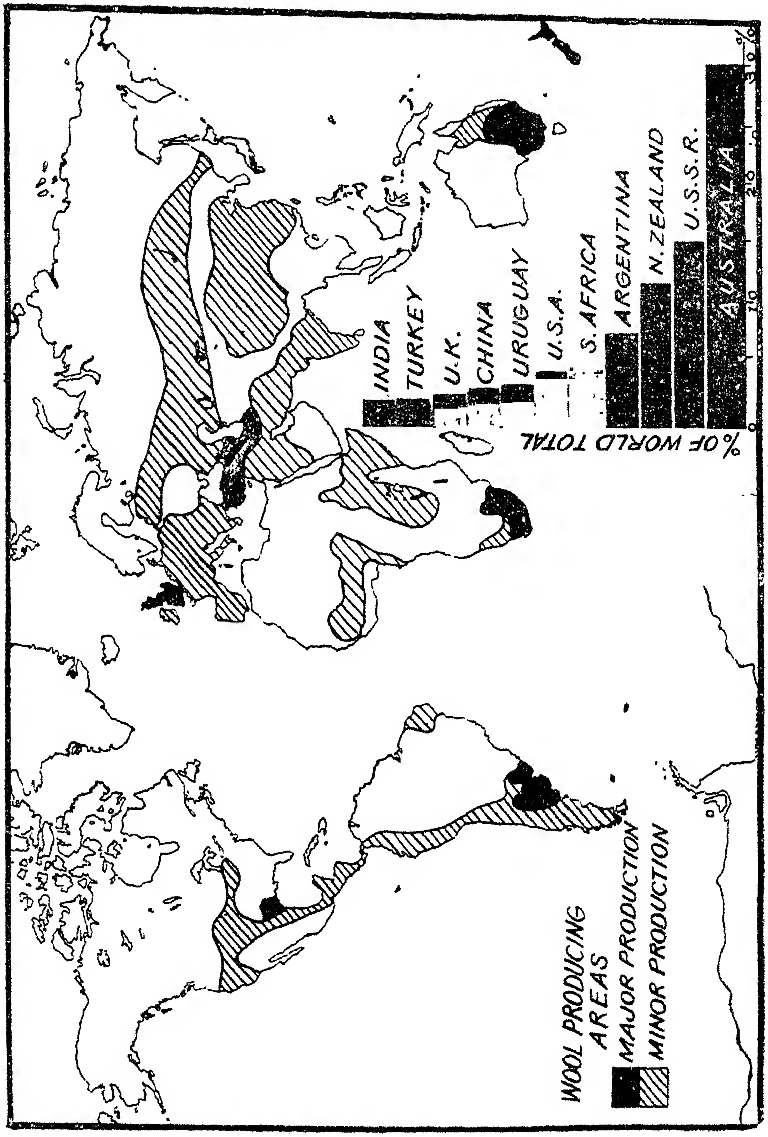


Fig. 23·10. Wool Producing Countries.

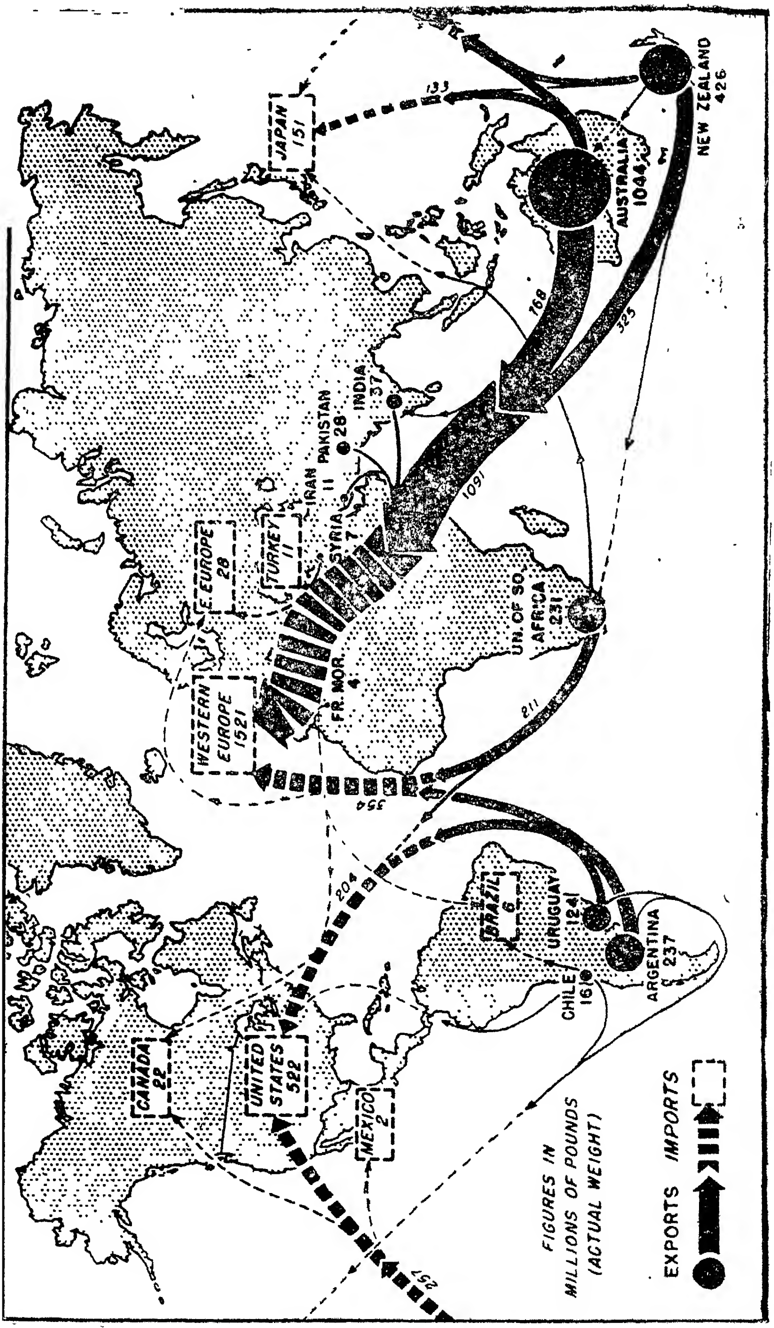


Fig. 23·11. International Trade of Wool

wealth's economy. Wool alone contributes about one-fifth of the total value of Australian exports, as shown in fig. 23·11.

Sheep-farming in Australia is now mainly concentrated in New South Wales, especially in the rolling Downs on the western side of the Great Dividing range. During 1972-73 New South Wales had 62 million sheep and lambs. The production of wool in the same year was 260·2 million kg (greasy). The number of sheep and therefore the production of wool in Australia, varies very greatly in response to the climatic conditions. Some portion of Victoria is suitable for sheep farming. The wool produced in the year 1972 amounted to 192 million kg. valued at $ 135 million.

Queensland is another sheep farming and wool producer region of Australia. During 1973 the state had 13,346,000 sheep and lambs. The wool production (greasy) was 83·16 million kg., valued at $ 61·7 million. South Australia produced 106,006 metric tons of wool during 1972-73.

Aroung Perth, in western Australia also produces small quantity of wool. In 1973 western Australia had 30,919,180 sheep. The wool clip in 1972-73 was 147,355 metric tons ; the exports for 1972-73, greasy wool, 136,445 metric tons; degreased wool, 10,394 metric tons.

Tasmania is also wool producing country. Wool produced during 1971-72 was 21·1 million kg., valued at $ 18 million.

New Zealand

New Zealand ranks third in wool production. The moist, maritime climate and better posturage in the country have led New Zealand to specialize in meat rather than wool production, but wool is nevertheless an important item in the national economy. The climatic conditions favour English breeds of sheep. Westerly winds prevail at all seasons, and bring a heavy fall to the western seaboard, where it is promoted by the southern Alps. These mountains are therefore well forested, and the luxuriant vegetation includes magnificent tree ferns. The drier Canterbury plains of New Zealand form excellent pasture-lands devoted to sheep and goats, and are also well suited for growing crops.

New Zealand is now the world's leading wool exporting and producing country. Production of wool for the year 1973 was 309,000 metric tons (greasy basis) ; exports of all wool in the year 1972 was 276,868 metric tons while during 1971 it was 256,151 metric tons.

U. S. S. R.

After Australia, the Soviet Union has the second largest number of sheep in the world. The sheep are kept mostly in Asiatic Russia on large state farms. Sheep are raised mainly for wool and tallow, though mutton is eaten in Caucasia and Central Asia. Producing above 340,000 tons of wool, concentration has been on improving quality. Before the Revolution, fine woolled sheep were found in Kazakhstan west of the Irtysh : the bulk of

the animals were coarse-woolled, fat-tailed varieties which have since been interbred with fine-woolled rams to produce a successful Kazake long wool. High mountain sheep have also been cross-bred to give a breed readily adaptable to long treks and poor posture, now found mainly in the Alma-Ata and Toldy Kurgan districts. Two-thirds of *Karakul* products come from the poor steppe of Uzbekistan, notably around Bukhara, Samarqand (Samarkhand), and in the Kashka Darya district. The Soviet Union has a large domestic market for woollen goods because of the cold continental climate with long severe winters experienced in most parts of the country. Russia, with about 15 percent of the world output of wool, is also increasing its production, especially in the large empty areas of the Siberia.

South America

Argentina and *Uruguay* are important sheep rearing nations of South America. Argentina accounts for more than 7 percent and Uruguay about 3 percent of the world's wool production. Throughout Central Argentina and Uruguay the prevailing vegetation is grass, affording pasture for innumerable herds of cattle and sheep. This area is called the Pampas, but its aspect is not everywhere quite the same. In some of the eastern districts the tall grass is much mixed with clover, and with thistles, which necessitate special machinery in cleaning the wool of the sheep ; while towards the west the plain is dotted with shrubs. Though over large areas the grass seems to have prevented other plants from growing, there are patches rendered beautiful by scarlet and purple Verbena, and many varieties of polyanthus and lilies, as well as by tall clumps of the feathery Pampas grass. The chief inhabitants of the Pampas were formerly the Gauchos—men generally of mixed Spanish and Indian descent, who spent most of their lives on horseback tending the vast herds of sheep and goats. This region has a large proportion of merino sheep, but as a whole merino wool forms only about one-fifth of the total wool output. Other South American producers are Brazil and Chile but majority of the production is of medium and poor grade wool.

In *Chile* the climate and land of the Magallanes region are particularly suited to the raising of sheep. wool and frozen lamb provide substantial sources of foreign exchange. Many of the sheep farmers are British subjects. Throughout the country there are nearly 6·7 million sheep, and cattle number some 2·8 million. Chile is not self-supporting for beef and Argentina has to supply a proportion of Chile's needs.

In the Magallanes Pampa region and Tierra del Fuego there are about 3 million high grade sheep (chiefly Romney Marsh andt Corriedales). Output of wool is about 11,000 metric 7tons ; expor in 1969, 10,355 metric tons, valued at U. S. $ 7,836,71.

India

According to 1971 census India has about 42 million sheep,

but because of their poor health, they yield less than one kg. of wool each year. This is against the six kg. a year from Australias merino sheep.

Apart from the low wool yield (35 million kg. a year) it is the inferior quality which mainly accounts for the backwardness of sheep farming in the country. At 85 central and states farms Russian ewes and American rams are being cross-bred to produce fine wool flocks. This is part of an ambitious scheme to regain the markets India has lost overseas and to supply enough wool to mills which now produce only a third of what they can.

International assistance has come in a big way to help the Agriculture Ministry's sheep breeding programme. A UN project for shearing, grading and wool marketing in Rajasthan was successful. It is now being followed up by extending the scheme to seven more wool-producing states An improvement in the breed leading to a higher wool and mutton yield is supplied by Indo Australian sheep breeding farm at Hissar. The Hissar farm produces pure-bred Australian corriedale sheep for cross-breeding with Indian sheep at Government farm. The Government farms at Hissar is a typical large and modernized farm like the ones in Australia. Not only the animals but even the fodder grown there is of Australian variety. In the countryside, nomads with little knowledge of modern sheep rearing and shearing techniques look after sheep and goats.

Fine wool flocks are found only in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. But they constitute only a small percentage of the total flock. About 50 percent of the total flock found in south and east India give very little mutton and only hair. Because of the shortage of water, fodder and pastures, the standard of the flocks elsewhere is uniformly poor. The quality of wool is coarse and hardwearing. Under Indian climatic conditions, two shearings a year become necessary. This means the wool is short staple. Indian mills have to import long staple wool from Australia and New Zealand to blend with the Indian wool. Success in marketing and remunerative prices for farmers came when experimental sheep shearing, wool grading and marketing centres were established in Rajasthan under a five year UN Development Programme (Special Fund) in 1963. The Government has decided to extend shearing and marketing centres to seven more wool producing states—Gujarat, Maharashtra, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Uttar Pradesh, Panjab and Haryana. Under a Rs. 16 crores Central Plan. sheep breeding and development farms have been set up in the above mentioned eight states. Cross-breeding is the main plano of the Government programme. About 85 farms conduct cross-breeding, and pedigreed rams are supplied to progressive farmers through about 650 sheep wool extension centres.

The migratory and semi migratory flocks of sheep in Himachal Pradesh crossed with Russian merino, rambouillet or Polwarth

rams. It suggested introduction of dual purpose sheep like Corriedale and Dorset in orchards in Jammu and Kashmir and Himachal Pradesh. The main objective is to develop fine wool flocks all along the hill areas of U. P , Jammu and Kashmir and Himachal Pradesh.

Other Countries

Other wool producing countries are China, South Africa, Turkey, U. K., U. S. A., France, Spain, Belgium and Japan.

Trade of Wool

Fig. 23·11 shows that Australia leads the world in export of wool, followed by New Zealand, Argentina, South Africa and Uruguay. These two nations Australia and New Zealand furnish over two-thirds of all exports. Britain's woollen industry goes back to the Roman period, when both sheep farming and woollen cloth production were concentrated in the south of the country. Britain imports its wool principally from Australia, New Zealand, South Africa and Argentina and is a major exporter of cloth to European and African countries. The United States, generally ranking second after Britain in imports and first in consumption, purchases on the world market all of its carpet wool and from 40 to 50 percent of its apparel wool. The United States of America becomes Argentinas largest buyer, though West European countries has been moving up rapidly as a major market.

India produces what is known in the international market as carpet wool. This is suitable only for making carpets, blankets, *Kambals* and other coarse woollen fabrics.

India imports about Rs 20 crores worth of fine wool every year. But this is less than a third of the mills requirements, and, consequently, they work much below their rated capacity. The mills consume only 10 million kg. of Indian wool.

Synthetic fabrics had cost India a number of her overseas buyers. At one time India was exporting about 30 to 50 percent of its production, but now she exports less than a fourth of her output.

CHAPTER 24

BEET SUGAR AND SUGARCANE

The cultivation of Sugarcane has made enormous progress in various parts of the world within very recent decades as a result of the growth of cane-sugar industry under the various states protection.

One of the great principles of Geography of Resources, as mentioned in Chapter 1, is the principle of maximum utilization of natural gifts. As already indicated, these limits may be set up by nature or they may be created by man. It may be well to examine both nature and man-creations in the study of Sugarcane, as shown in fig. 24·1, produced in great quantities South of 35° N. latitude, and beet Sugar, an important commercial crop North of 35° North latitude in temperate regions. But Sugarcane inspite of Sugar beet is extremly significant in world trade.

Ecological Conditions

Sugarcane crops require such geographical or ecological conditions as exist in Java and Cuba, where there is a temperature of 20°C to 26°C the year round and the rainfall 137 cms or more. Much sunshine is required, particularly at the end of the growing season, to produce cane with a higher sugar content. Sugarcane cultivation in the world extends south of 35°N. latitude, and the crop is grown under widely varying conditions of rainfall soil and climate. But certain environmental factors are essential for its development, viz :—

The fertile alluvium soil which is renewed every year by the numerous mountain streams flowing into the area-sugarcane grows well in alluvium and light-clay. The soils of the Sutlez-Ganga plain only for example contain nitrogenous materials and here the cane cultivation can be done even without the aid of manures and fertilizers. Although sugarcane is grown in the whole of Sutlez–Ganga Plain but the areas of volcanic soils such as Java, Cuba and Hati- etc. have a commercial production.

High water level enabling easy irrigation. The plain of Indo-Ganga provides very little ecological conditions for the growth of sugarcane. In this region whenever the rainfall lacks, the water from local canals is restored to the water requirements are fulfilled. It cannot resist frost. For this region the cane harvest begins with the approach of winter. The rainfall for its well growth must be from 137 to 150 cms which is partly supplemented by canals.

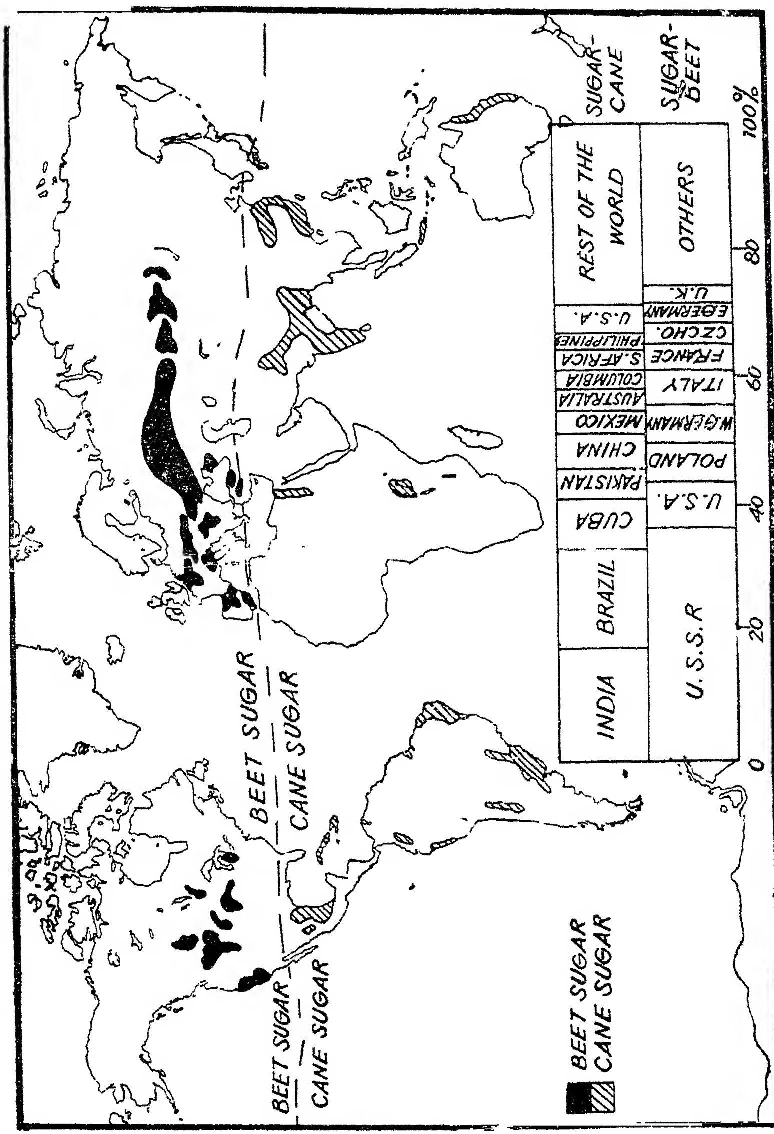


Fig. 24 1 Ecological limits of Sugar beet and cane.

Sugarcane Producing Areas

Sugarcane is grown in a very wide range of tropical and subtropical countries but the largest producers are from two main regions firstly from South Eastern Asian nations and secondly from Latin American countries. It is chiefly produced in Cuba, India (where it is used for home consumption) Java, Brazil and Hawaiian Isles.

Sugar in Volcanic Islands

The Sugarcane requires a rich soil, but demands little attention ; for though the canes, which attain a height of 3 to 5 metres, have yearly to be cut to get the sugar, the roots continue to send up fresh shoots for about five years. As these shoots, become less productive, however, in course of time, in many part the canes are replanted every three years. After the canes are cut, and crushed to extract the juice, they are used as fuel ; while the juice is boiled and treated so that part crystallizes as sugar and part flows away as molasses.

Sugarcane is chiefly grown in Volcanic Islands of Hawaii, Java, Cuba, Philippines, Pureto Rico etc. Because of several advantageous factors, the Volcanic islands of Pacific and Atlantic have attained a position in respcet of sugarcane farming which is the envy of practically every cane farming nation in the world today. It must, however, clearly understood that natural advantages such as a rich volcanic soil, favourable trade winds and a tropical climate not characterised by marked fluctuations in temperature have gone a long way towards establishing a highly efficient sugarcane farms in these islands, sheer hard labour, systematic farming methods, intensive research, and huge investment of capital have all contributed in no small measure to the attainment of this objective. With a standard of living approaching that of the United States and a high level of minimum wages resulting therefrom, the volcanic Islands cane farmers have had to spend large sums of money on mechanisation to effect an economy in labour operations. Much expenditure had also to be incurred on the breaking up of the volcanic rock as well as well as the construction of elaborate irrigation systems. Weather conditions in these Volcanic Islands vary from place to place but in general, windward areas are wetter than those leeward with the result that temperatures are somewhat higher in the latter. August and September are the warmest months of the year while January and February are the coolest. Further, the daily variation of temperature from day to night is greater in the leeward areas, though a difference of about 4°C is not unknown in a few places. Tenacious trade winds are also a prominent feature and the persistently equable temperature, devoid of marked or sudden changes, lengthens the phase of growth of sugarcane plant, maturity being attained after a long period of 22 to 24 months.

The soils of the islands are essentially volcanic, consisting of lava formations thrown up by volcanic erup tions through the ages

and slowly weathered by natural agencies. Normally the lava remains unfertile through a period of about 20 to 25 years during which weathering takes place. After this, excellent crops can be grown aided by copious manurial dosage. Weathering is, however, governed by various factors such as temperature and rainfall and, in humid areas with high temperatures, chemical weathering is dominant. Most soils are clays or clay loams with little difference in soil and sub-soil except in the degree of weathering. All plots are not level for much of the area is rough and even steep slopes are cultivated, but in general 60 metre is the lowest level at which sugarcane is raised.

As already mentioned irrigation is almost universal but in several places dry cane-farming is practised where irrigation facilities exist, enormous sums of money have been spent in the construction of large water basins or reservoirs where mountain slopes supply all the water needed for sugarcane farming. In other places, underground water is tapped and artesian wells give a constant water supply to the farms.

Manure varies from place to place consistent with the chemical composition of the soil and the requirements of the sugarcane crop in that area. Generally, nitrogen is given in the shape of Aqua Ammonia (20·5 percent) in four to five applications, according to the category of requirements for a 24 month crop. In the plant cane nitrogen is applied in irrigation water when cane is 4-5 months old and up to four applications are given. In the ratoon crop the first dose of manure is given by sub-soil fertilizer tractor 39 apart on both sides of the cane furrow 8 to 10 cms. deep. All second season applications are given at least 12 months before the start of cane harvest, Potash is given also in irrigation water in the shape of aqua-potash.

Method of Cultivation

The preparation of land varies a great deal from place to place but generally deep ploughing is done as soon as land is available with a heavy oliver 5 disc plough to a depth of about 40 cms. The soil is then worked up with the help of a heavy, Rome disc harrow, followed by lighter discing by smaller harrows, followed by lighter discing by smaller harrows. Furrowing is done by a three-line furrow plough mounted on a D6 caterpillar tractor. Often the initial breaking up of the soil is done by heavy subsoils followed by heavy disc ploughts. Numerous rocks in many areas have made it necessary to go into an accelerated rock clearing programme. Planting is mechanised and furrows are laid out at distances of one and half metre in the low lands and 2 metre in the elevated areas. Seed spacing is 3 cms overlap and planting is carried out at a soil depth of about 3 cms. Seed is cut mostly by hand and selected setts are put in bins which are tractor-handled. Prior to this, the seed is treated with a spray of phenyl mercuric acetate as a prevention against disease Planting is done by one bulk-seed planter working two shifts and this planter furrows, lays seed, fertilizers

and covers in one operation. In certain areas mechanical planting is done, which is followed by small hand tractors to cover up the furrows.

Sugarcane diseases are controlled by planting resistant varieties. Two cane diseases, downy mildew and Fiji diseases, a latter being more serious, constitute a menace to the sugar industry. The object of ripening control is to obtain the highest possible sugar yields per hectare at harvest by controlling the moisture content of the cane as it nears maturity. Weekly sheath moisture samples are taken for all fields which are seven months or less from harvest. These samples are chartered and irrigation adjusted to reduce the sheath moisture percentage along a moisture line extending from 7·8 percent to 83 percent moisture in the seven-month period. In order to rid the fields of the matters of dead cane leaves that form round the stalks, the cane is burnt just prior to harvesting operations. Normally, 24 hour supply of cane is burnt, one at a time, with the average time between burning and crushing being not more than 24 hours. Powerful tractors equipped with watson type bulldozer rake Knives and crawler cranes are the principal machines used in harvesting. Generally crushing starts about the middle of January or February and goes right up to November or even the end of December. Normally factories depend upon their own plantation cane, though in some places growers cane is also used.

Cuba

Cuba's soils is fertile and up to two annual crops can therefore be obtained. The climate of the Cuba is hot, though tempered in parts by altitude and by the north-east trade wind. Most parts, save a few low coastal plains, are healthy, but terrible destruction to life and property is occasionally wrought by hurricanes, which are most frequent in September. The heavy rain in summer, when the north-east trade wind is strongest, have promoted a luxuriant vegetation everywhere, and clothed the eastern slopes of the ranges with forests.

Cuba is famous for its production of Sugarcane. Sugar production is the main source of foreign exchange earnings. In 1970 production was 8,537,600 tons which is the highest ever, and what is more the highest canesugar production achieved by any country. In order to mechanize agriculture, 56,166 tractors and 7205 cane Sugar lifters were imported in the period 1959 to 1970.

CARIBBEAN LANDS

In Caribbean sea sugarcane is chiefly, produced in Haiti, Puerto Rica, Jamaica and other islands. These islands rise from deep water and separate the Caribbean sea from the Atlantic. All the islands are mountainous with Volcanic soil. Sugarcane is the chief product of these islands.

The sugarcane is grown on the coastal lowlands, the windward northeastern side of Puerto Rico having sufficient rainfall for the

crop in most places, but on the drier 'south-western side irrigation is necessary.

Java

Of all the Indonesian islands, Java is the most productive—and hence most densely populated on account of its fertile volcanic and alluvial soil. Every square centimetre almost of the deep Volcanic soil is cultivated. Rice and sugarcane are grown in the lowest levels. Sugarcane is grown on wet lowlands Most of the plots are small, about ·8 hectare only. usually the original population or native just grows enough sugarcane for himself. Colonial plantations are often over 400 hectares in size. They are planned and managed by foreigners, but the spade-work is done by original population. Java is fourth after Cuba, Brazil and India in the production of sugarcane.

Java was once a very important sugar producer—second only to Cuba, now the sugarcane has declined and Java now has to import supplies to supplement its production, instead of being an exporter. Most other south-east Asian countries produce some sugar for local requirements. Java only produces 2% of the world total.

Philippines

In south east Asia the Philippines is now the leading sugarcane producer of the world. Most of the soils is volcanic and fertile. The temperature is reduced in most parts by elevation, and modified by oceanic winds. All regions experience a fairly heavy rainfall in summer, which is excessive on the south western slopes of Philippines The varied climate and soil condition enable a wide range of agricultural products to be grown. The main farm crops are rice tobacco and sugarcane. Sugarcane is commercial crop and occupy the largest hectarage. Sugarcane is widely grown all over the islands but commercial production is largely confined in the islands of Panay, Negros, Luzon, Cebu and north of Manila. Sugar is the chief export. Its main markets are the United States and Japan, both of which import crystal sugar from Philippines.

China

Climate plays a large role in sugarcane production in China. There are great irregularities in the rainfall and growing conditions in China. Sugarcane is the main crop of Southern China. South eastern China has a climate which somewhat resembles that of the Eastern United States. Chinese winters are colder, summers are hotter. Sugarcane is mostly grown on monsoonal areas of Southern China. Sugarcane grows in the wetter parts of the lowland valleys and above the sugarcane on the terraced hill sides are grown rice, maize etc. Si-kiang basin is important sugarcane producer of China.

Hawaii Islands

The Hawaiian islands are at the summit of a long chain of

oceanic mountains of volcanic origin, stretching nearly three thousand kilometres in the Pacific ocean. Sugarcane production the islands top industry, is vitally important to Hawii. It is grown on only four of the numerous islands situated between 19 and 21 degrees north latitude and 155 and 160 degrees west longitude, comprising about 88,800 hectares or roughly two-thirds of the land available for cultivation. Sugarcane can be successfully grown on the same plot without a break for over forty years, through normally three or four ratoon crops are taken in most areas. Journeying from windward to leeward slopes a pronounced and sudden decline rainfall is generally noticeable. This condition in amply illustrated in Central Kauai where, near the summit of mount Waialeale at an elevation of 1540 metre, the annual amount of rainfall average over 1000 cms, while about 24 kilometres south west or to the leeward at Waimea and Waiawa where elevations approach the sea level the annual rainfall is only 50 cms. Another feature is that while areas comparatively close to the sea level receive less rainfall, heavy precipitation occurs in elevated areas. Rainfall is heaviest in the winter and spring months, and though most of the sugarcane farms have elaborate irrigation systems, there are quite a number of farms depending entirely on rainfall.

Sugar mills in Hawaii manufacture mostly raw brownish coloured sugar which is then shipped to the huge refinery on the mainland, maintained cooperatively by all the sugarcane plantations. A small refinery at Aiea, Oahu, refines sugar for consumption in Hawaii.

South America

Brazil is the leading producer of South America. Sugarcane is grown mainly on the south eastern coastal region of Brazil. To the north east, an area of heavy concentration is located near the intersection of the coastline and lat. 10° S., farther south, another is situated at the approximate intersection of that coast and the Tropic of Capricorn. Brazil dominated by tropical Savanna climate, contains much land conducive to Sugarcane growth. The crop is seen almost everywhere around Sao Paulo.

Sao Paulo and adjacent regions produce more than one-half of the Brazil's sugarcane. Brazil ranks first only in South American production of sugarcane. Sugar production, 1970 was 5069,929 metric tons while in 1971 it was 5081,434. Exports in 1970 it was 1·49 million metric tons.

Colombia

Colombia is the second largest producer of sugarcane only in South America. Very little or the country is under cultivation, but much of the soil is fertile and is coming into use as roads improve Central America.

Costa Rica, Nicaragua, Honduras, Guatemala and Mexico are other important producers. In Mexico sugar output sence 1946

has left surpluses for export. Mexico produces about 5% of the world's output of sugar.

Australia

About 1600 kilometres eastern coastal region of Australia from Queensland to New South Wales produces sugarcane. Most of the sugar is consumed at home while small amount being exported to foreign countries especially to Japan. Human labour is available at hand. High labour costs raise production costs so that sugar growing is subsidized by the grovernment, Australia produces about 3°/₀ of the world's sugarcane.

Pakistan

In Indo-Pak continent sugarcane is grown under intensive subsistance type of agriculture. Yield per hectare is very low. Lahore, Lyallpur, Multan and Sialkot are important districts of sugarcane. Humid subtropical climate with moderately dry winters prevails over the northern growth area especially in Quetta and Rawalpindi. In both north and south districts of Pakistan higher yields are achieved with irrigation.

African Countries

Growth of sugarcane in Africa has expanded very rapidly because the climate and topography are very suitable for sugarcane growth. The temperature is generally high, though reduced by altitude on the table lands. The rainfall is fairly heavy, and falls mainly during the respective summers of the areas. In the east it is due to the south easterly trade winds, and elsewhere is the result of the seasonal shifting of the Equatorial belt of heat and low pressure and consequent indrought of air. Wherever irrigation is possible, as in the Nile valley, valuable crops can be grown. Sugarcane is mostly grown in Nile Valley, Kenya, Uganda and Western African countries.

India

At one time India had the largest hectarage under sugarcane in the whole world. Indian hectarage was about three times that of Cuba and about seven times that of Java, the two islands which have dominated the world production of sugarcane in the past. India was also the largest producer of sugarcane in the whole world, producing about four times that of Java, Hawaii and Brazil, about three times that of Philippines and about one and a third times that of Cuba.

Sugarcane is grown all over India in favourable localities to some extent or the other, because of its great money yield, its greatest concentration occurs in the submontane districts of the Middle Ganga Valley, where U. P. has 59 percent of the total Indian crop, the Panjab 10°/₀, Haryana 5°/₀ and Bihar 17°/₀ together accounts for four-fifths of the sugarcane area of India, while rest is grown by other states.

In Uttar Pradesh the most important districts producing

sugarcane are Shahjahanpur, Faizabad, Azamgarh, Ballia, Varanasi, Jaunpur and Gorakhpur. In Western U. P. Meerut, Bulandshahr, Saharanpur and Muzaffarnagar are important sugarcane producing districts while Bijnor, Rampur, Bareilly and Pilibhit are situated in Tarai and Bhabar regions of U. P. U. P. long raises 59°/₀ of the Indian crop. Fig. 24·2 shows the important sugarcane growing areas of India.

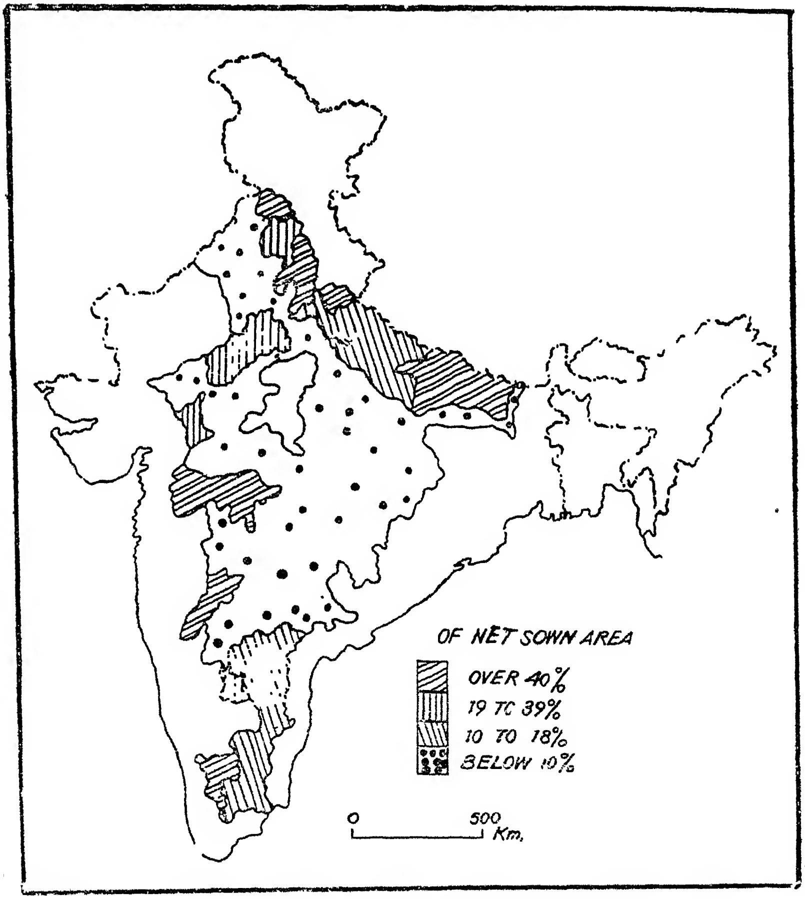


Fig. 24·2. Sugarcane Growing Areas·

In Bihar the important sugarcane growing districts are Champaran, Saran, Darbhanga and Muzaffarpur. Almost 17°/₀ of India's sugarcane comes from Bihar.

Sugarcane is grown in Amritsar, Jullundur, Ludhiana and Ferozpur districts of the Panjab.

In Haryana the area under sugarcane in Rohtak and Karnal

districts is more than the area in any district of the Panjab. About 5 percent of India's sugarcane comes from Haryana. Sugarcane, where grown is of superior kind, the juice is used for making sugar and gur.

There are, however, small areas of one cultivation spread locally all over the country. The existence of such areas clearly proves the importance of sugarcane as a money crop to the Indian cultivator. Sugarcane is also grown in South India. In both north and south, higher yields are achieved with irrigation. The long break in the rains in India does not favour the growth of thick, juicy canes under average conditions. The cane which has practically supplanted the old indigenous varieties in India is the Coimbatore cane, bearing different numbers according to the seedlings obtained by crossing with different varieties as well as with other plants like **Jowar.** Coimbatore has been selected as the centre for researches in sugarcane, because its climate is ideally suited for cane.

Production and hectarage in India

Most of the cane produced in India is used locally for crushing in the sugar mills erected all over the sugarcane area in the country. One of the main factors in the rapid increase of sugar cultivation in India has been the demand for cane from these mills. The land lying near these mills, wherever practicable, has all been converted into sugarcane land, the cane replacing all other crops. An important example of this replacement is noticed in the Terai region of the U. P. where the land, farmerly given to rice, is now devoteo to cane.

Sugarcane is grown in almost all the states of India, but its cultivation is mostly concentrated in U. P., Panjab, Haryana, Bihar, Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka etc. The average area under sugarcane in India during the year 1950–51 was 1,07 thousand hectares. The highest hectares was recorded in 1960–61 when it reached a peak of 2415 thousand hectares The year 1973–74 saw a further increase in hectarage reaching a new height cf 2722 thousand hectares. The following Table 24·1 shows the statewise hectarage and production of sugarcane in India.

Table 24·1

Hectarage and Production of Sugarcane in India—1973–74
(Mid-period figures)

State	Area thousand hectares	Production thousand tons
Andhra Pradesh	120 7	9209 2
Assam & Maghalaya	34·3	134·7
Bengal	33·9	1558·8

Bihar	134·3	4753·0
Gujarat	38·2	1801·1
Haryana	13·6	600·1
J. & K.	1·3	15·3
Kerala	7·8	400·2
Madhya Pradesh	54·6	1450·0
Tamil Nadu	11·3	9770·2
Maharashtra	18·0	11,917·7
Karnataka	104·2	8548·3
Orissa	30·7	1961·4
Panjab	105·0	4840·0
Rajasthan	33·9	1349·8
U. P.	1341·8	57,743·4
Delhi	1·1	5·7
H. P.	3·5	46·3
Tripura	2·1	65·4
Pondichery	1·6	152·0
Goa, Daman & Diu	0·2	1·5*

Production of sugarcane in 1950–51 was 5,70,51,000 tons. The highest production was during the year 1972–73 when it reached a peak of 12763 thousand tons which further increased 14046 thousand tons in 1973–74. The following Table 24·2 shows the area and production of sugarcane in India.

Table 24·2

Area and Production of Sugarcane

Year	Area under sugarcane (in hectares)	Production (tons)
1971–72	N. A.	901
1972–73	2454	12763
1973–74	2722	14043

Exports of Sugar

Early last year India were completing a programme of profitable exports which earned the country about 12 crores of foreign exchange. Consumption and exports are shown in Table 24·3.

* Provisional Figures.

Table 24·3
Consumption and exports of Sugar in India.
(Figures in lakh tons)

Year	Consumption	Exports
1965–66	24·01	3·92
1966–67	26 01	2·35
1969–70	32·64	2·12
1970–71	36·00	4·00
1975–76 (estimated)	53 00	10·00

WORLD PRODUCTION OF SUGARCANE

The Indian Republic is by far the largest sugarcane producer accounting for almost 19 percent of the total world production followed by Brazil 13 percent, Cuba 8 percent, China 3 percent, Pakistan 2 percent, Mexico 2 percent and U. S. A. (including Hawaii) more than 3 percent. About three-fifths or perhaps more, of India's sugarcane is boiled into a sticky, brown mass called "gur" in which from it is ultimately consumed. The remaining two-fifths is processed initially in modern mills and subsequently forwarded to centrifugal plants to be refined into white sugar. The production of centrifugal raw sugar is given in Table 24 4.

Table 24·4
Production of Centrifugal raw Sugar from Sugarcane
(Figures in 1000 metric tons*)

Countries	1970	1971	1972
Argentina	979	996	1303
Australia	2514	2794	2816
Barbados	157	137	113
Brazil	5447	5730	6283
Cuba	7559	5990	4688
Dominican Rep.	1015	1131	1201
Egypt	491	515	653
Fiji	361	322	303
Guyana	316	375	320
India	4633	4131	3383
Indonesia	713	834	889
Italy	1202	1232	1257
Jamaica	576	621	686
Mauritius	576	612	688

* The Statesmans Year Book 1974/75.

Mexico	2365	2562	2526
Pakistan	680	593	399
Peru	773	913	922
Philippines	1926	2058	1859
Puerto Rico	413	291	268
Rep. of S. Africa	1399	1865	1915
Trinidad	221	267	292

SUGARBEET

Like sugarcane, sugarbeets are produced chiefly for their sucrose content. While the sugarbeet will grow in a very wide range of environment—the climatic conditions for sugarbeet production are exacting—a moderate amount of spring and summer rain and a summer of moderate temperature, but not too high, and a cool, cool autumn. Sugarbeet is usually cultivated as a rotation crop in northern temperate countries of Europe and North America. The most important factor in its cultivation is the existence of suitable deep friable and fertile soils. The best yields and quality are obtained from fertile, m. llow soils rich in time, and neither too clayey nor to sandy, finely prepared, and plowed so deeply that a sub soil plow must often follow the ordinary plow. Such conditions occur at various places in the Northern European Plain and Siberia.

Beet-Sugar Producing Areas

Sugarbeet is chiefly grown on well-manured fields in Central Germany, Czechoslovakia, France, Holland, Belgium, Finland, U. K., Bulgaria, Spain, Italy, United States and Soviet Union. While sugarbeets are grown in every country of Europe and Germany ranks second in production after the U.S S.R. France usually ranks third in production behind the Soviet Union and Germany. Fig. 24·3 shows the beet sugar producing areas of Europe.

In Germany beet hectarage is about equally divided between the Federal Republic of Germany and German Democratic Republic, but higher yields in Federal Republic of Germany or West Germany give it a greater production of sugar. In Western Germany important sugarbeet growing areas are Schleswig-Holstein, Saarland, Lower Saxonv, North Rhine—Westphalia, Hessen, Hamburg, Bremen, Bavaria, Baden-Wurttemberg, Rhine land and Palatinate. Production and area of sugarbeet is given in Table 24 5.

Table 24·5

Area and Production of Beet Sugar in Western Germany

Areas	Area in 1000 hectarage			Yield in 1000 metric tons		
	1970	1971	1972	1970	1971	1972
Barden Wurttemberg	19 8	19·9	20·7	910·2	864·2	1013·5
Bavaria	61·5	68·3	74·2	2865·9	3268·9	3614·8

Hessen	19·9	20·6	21·5	880·3	922·4	872·2
Lower Saxony	109·3	113·4	116·0	4360·4	5058·5	4705·2
North Rhine-Westphalia	62 5	63·5	67·5	2988·2	3092·5	3005·0
Rhine land-Palatinate	20·1	21·6	22·0	1010·9	1049·2	1128·0
Saarland	—	—	—	0·1	1·2	0·6
Schleswig-Holstein	15·0	15·0	16·2	565·2	596·1	610·6

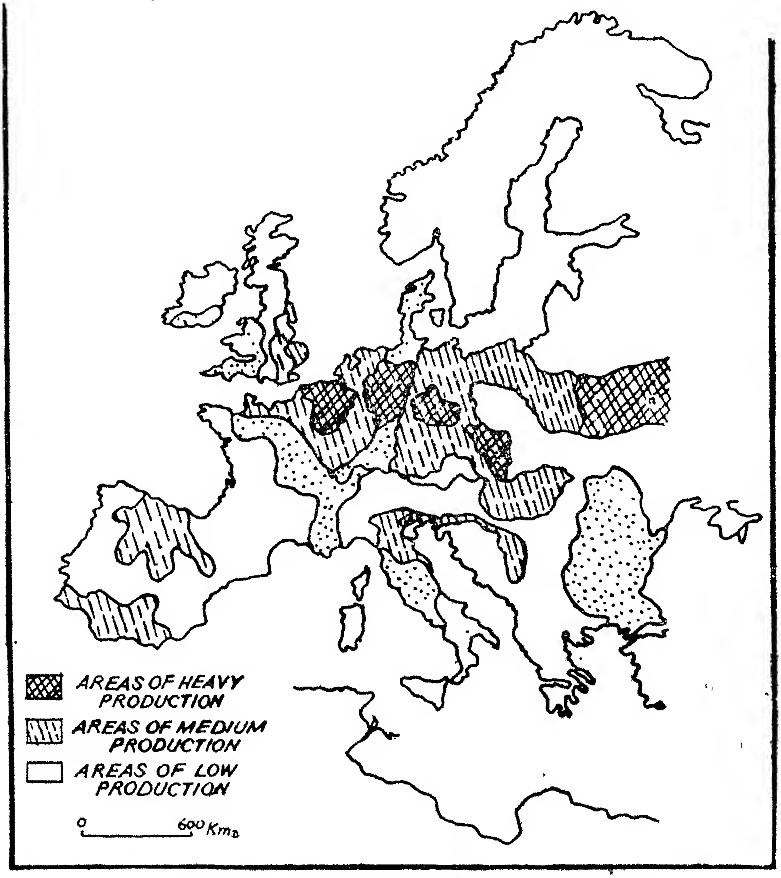


Fig. 24·3. Sugarbeet Growing Areas of Europe.

In the Middle Elbe Valley, near Magdeburg in German Demo-

cratic Republic, Sugarbeets occupy from one-tenth to one seventh of all the cultivated land. Here the beet fields spread in great expanses over the level, perfectly tilled plains and the whole landscape is dotted sugar mills.

France ranks second in Europe in beet sugar production. Most important productive area is Picardy. The land here is rather flat, but dips slightly in the middle, so that the upper Seine, Yonne, Marne and Oise flow down towards the centre. The wide expanse of nearly level cultivated land which forms the basin has a somewhat monotonous aspect, for the fields are rarely divided by hedges, though the straight roads are often flanked by poplars. The soil, however, is fertile and much sugarbeet is grown there. The following Table 24·6 shows the area and the production of sugarbeet for last four years.

Table 24·6

Area and Production of Sugarbeet in France

Year	Area (in 1000 hectares)	Production (in 1000 quintals)
1969	401	179,002
1970	403	175,215
1971	425	199,511
1972	448	192,757

Other important sugarbeet producing countries are Belgium, Poland, Spain, Portugal, Hungary etc In Spain during 1968, 180 thousand hectares were under sugarbeet, in 1969 production of sugar was 4620 thousand metric tons. The area and production is given in Table 24·7.

Table 24·7

Area and Production of Sugarbeet in selected countries of Europe

	Area in 1000 hectares				yield in 1000 metric tons			
Countries	1969	1970	1971	1972	1969	1970	1971	1972
Poland	—	408	421	438	—	12700	12557	14341
Spain	194	217	215	—	5079	5071	6214	—
Hungary	—	—	—	—	—	174	2023	2909
W. Germany	295	303	315	331	12941	13329	14409	14656
France	401	403	425	448	179002	175215	199511	192757
Belgium	—	326	306	281	2965	3052	2413	—
Australia	—	—	—	—	321	298	—	—

The Soviet Union

The U. S. S. R. ranks first in sugarbeet production and along produces over 37°/₀ of the world's beet sugar. Soviet Sugarcane is grown primarily in the Ukraine, which is responsible for nearly three-fourths of the national supply. Secondary growth areas include the lower Volga River region of the eastern European section of the country, and irrigated places in Soviet Central Asia. Almost two-thirds of the sown area is in the Ukraine and most of the remainder lies in the black earth belt in Northern Caucasia and the Middle Volga as well as Moldavia. Fig. 24·4 shows the important beet-sugar producing areas of the Soviet Union.

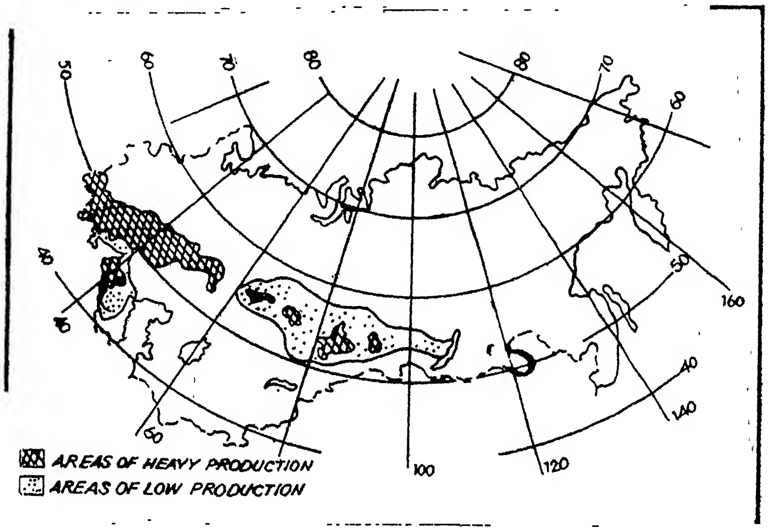


Fig. 24·4. Beet-Sugar Areas of U. S. S. R.

In the Ukrainian wooded steppe about a tenth of the area is under beet sugar cultivation. Although it is machine sown, mechanized harvesting is limited. In the Ukraine, chiefly under a humid continental warm-summer climate and a chernozem or related black soil, the crop is grown on both collective and state farms in association with sunflowers, flax, hemp and other commodities. Production of sugarbeet in the U. S. S. R. is given in table 24·8.

Table 24·8
Production of Sugarbeet in the Soviet Uuion

Year	Production Figures in million metric tons
1950	19·7
1960	52·2
1970	71·4
1972	68·0

U. S. A.

The beet sugar area of the United States is several times as large as the possible cane sugar area, and divided by 12° July isotherm as shown in Fig. 24·5. In western United States the crop is grown quite successfully in numerous irrigated valleys. Some twenty two states grow sugarbeets, though more than half the total output comes from three—California, Colorado and Idaho. California ranks first in U. S. A. and leads all states in the growing of beet sugar. Other important sugarbeet growing states are New Mexico, South Dakota, Nebraska, Iowa, Wisconsin, Michigan,

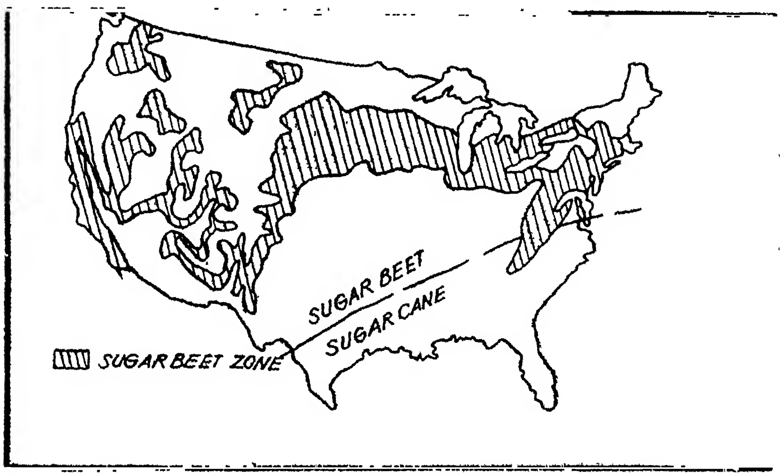


Fig. 24·5. Beet Sugar and Sugarcane Areas of U. S. A.

Ohio, New York, Pennsylvania, West Varginia etc. Large areas are, however, now cultivated, especially in the North West, where the rainfall is better and the soil more fertile, sugarbeet is widely cultivated but south of 12° July isotherm most area is only devoted to sugarcane. The production of beet-sugar involves a good deal of labour, and expensive machinery is required to refine it. The refuse beet, after the extraction of the sugar, however, forms a good food for cattle Many sugar factories are located close to the beet fields of North America.

Sugarbeet Production

Commercial sugarbeet production originated in Europe and the Soviet Union. These two produce 80% of the world's total sugarbeet. The production of sugar in India previously used to surpass all countries producing beet sugar, but recently the U. S. S. R. has started producing beet sugar which is even greater than the output of cane sugar in Cuba. The Soviet Union ranks first in sugar production from beet sugar and produces 12% of the world's total followed by U. S. A. 7 percent, France 4 percent, West

Germany 3 percent, and Poland 2 percent. The following table 24 9 shows the production of sugar from beet-sugar in selected countries of the world.

Table 24 9

Sugar Production from beet sugar in selected conntries of the world. (Figures in 1000 metric tons)

Countries	Production			
	1969	1970	1971	1972
Canada	135	107	149	125
China	3558	3657	3993	4046
Czechoslovakia	716	763	714	753
France	2473	2696	3202	2981
East Germany	440	490	530	641
West Germany	2019	2056	2342	2214
Italy	1378	1202	1232	1257
Poland	1527	1505	1713	1830
Spain	795	796	1047	826
Sweeden	207	220	267	292
U.S.S.R.	8853	9293	8217	8315
U. K.	937	984	1181	965
U. S. A.	5066	5277	5432	5773

In total sugar production the Soviet Union ranks among the world's leading producers of sugarbeet. The sugarbeet is a more costly source of sugar than is cane, and most countries making use of it have substantial import tariffs or quotas to enable the domestic industry to continue. Many cane-sugar producing countries, along with both the domestic cane and beet industries, have been eager to increase their quotas.

Trade of Sugar

As a matter of fact about 50% of the world's total sugar produced by developed countries 30% by developing countries and 20% by Communist countries but international trade in sugar is largely a movement from developing nations to technically advanced nations, most of which are active beet growers. The world markets are dominated by sugar cane grower nations, which makes up over 80% of the international trade and nearly all the overseas trade in sugar. The following Table 24·10 shows the international trade of sugar.

Table 24·10

International Trade of Sugar

	Exports in lakh tons	
	1967	1968
World	205	202
Exports	173	—
Developed countries	39	40
Western Europe	12	13
North America	0·2	0·2
Oceania	17	17
Others	9	10
Developing countries	**139**	**131**
Cuba	57	48
Latin America	46	47
Asia & Oceania	24	24
Africa	12	13
Centrally Plained Countries	**28**	**30**
East Europe	13	15
Soviet Union	11	12
China	4	3
Others	—	—
	Sugar—Imports (lakh tons)	
World	**200**	**202**
Tolal imports	168	—
Developed countries	119	120
W. Europe	48	45
U.S.A.	42	46
Others	28	30
Developing countries	**41**	**43**
Latin America	2	3
Asia & Oceania	23	24
Africa	15	15
Centrally Plained Countries	**39**	**39**
East Europe	7	0·7
U.S.S.R.	25	24
China	6	6
Others	0·2	0·2

Cuba's chief exports is sugar. Sugar accounts for almost 85% of the total value of exports. Total estimated value of exports in 1964 was 600·7 million dollars.

India, Java and Philippines are also exporters, but on a small scale. The sizable list of additional exporters includes Australia, the Soviet Union, Poland, France, the Dominican Republic and the United Kingdom. These countries generally represent surpluses of domestic production over consumption.

The outstanding importing countries are the United States of America (25 percent of the total world's import) followed by Soviet Union 13 percent, the United Kingdom 12 percent, Japan 9 percent, Communist China 5 percent, European Economic Community 9 percent, Rest of Western Europe 8 percent and Rest of the world 19 percent. The first three (U.S.A., U.S.S.R. and U.K.) receive about 50 percent of all incoming sugar.

CHAPTER 25

AGRICULTURAL REGIONS

Agricultural Regions as Geographic Units

Agricultural region is, no doubt, of a great importance from the point of economy. The present contribution, however, aims at drawing attention to its theoretical significance, to the position of agricultural regions in an imaginary system of geographical units which would cover the whole solid surface of the globe, an idea suggested first by D. Whittlesey during 1936.*

Basis of Classification

According to Whittlesey any classification of the agricultural region must be based upon the following criteria :

1. Crop and Animals association,
2. Capital labour force used in agriculture,
2. Productivity of agriculture,
4. Consumption patterns of agricultural production,
5. Method and techniques used in agriculture.

In the above mentioned criteria the economic doctrines prevail over the geographical doctrines : the results, however, are doubtful and not satisfactory from the point of geography. Roughly speaking, similar combinations of elements reappear in similarly situated parts of the world, so that if the different continents are divided into agricultural regions the same type recurs several times. Every greater changes occurring in production, develops new production relations while abolishing the old once. Such a practical orientation, however, is misleading as it does not follow the real geographical way of thinking. In the last of this chapter I would like to point at two geographical ideas which, when applied, are still more applicable. It is the geographical notion of boundary and the idea of geographical inertia.

Agricultural Regions

Whittlesey is the first geographer who studied the patterns of agricultrue of the whole world. He has proposed the use of economic factors Whittlesey's agricultural regions are shown in fig. 25·1.

Whittlesey divides the agricultural regions into following ten divisions on economic functioning. These are :

* Whitt,esey, D , A A. A G. 1936

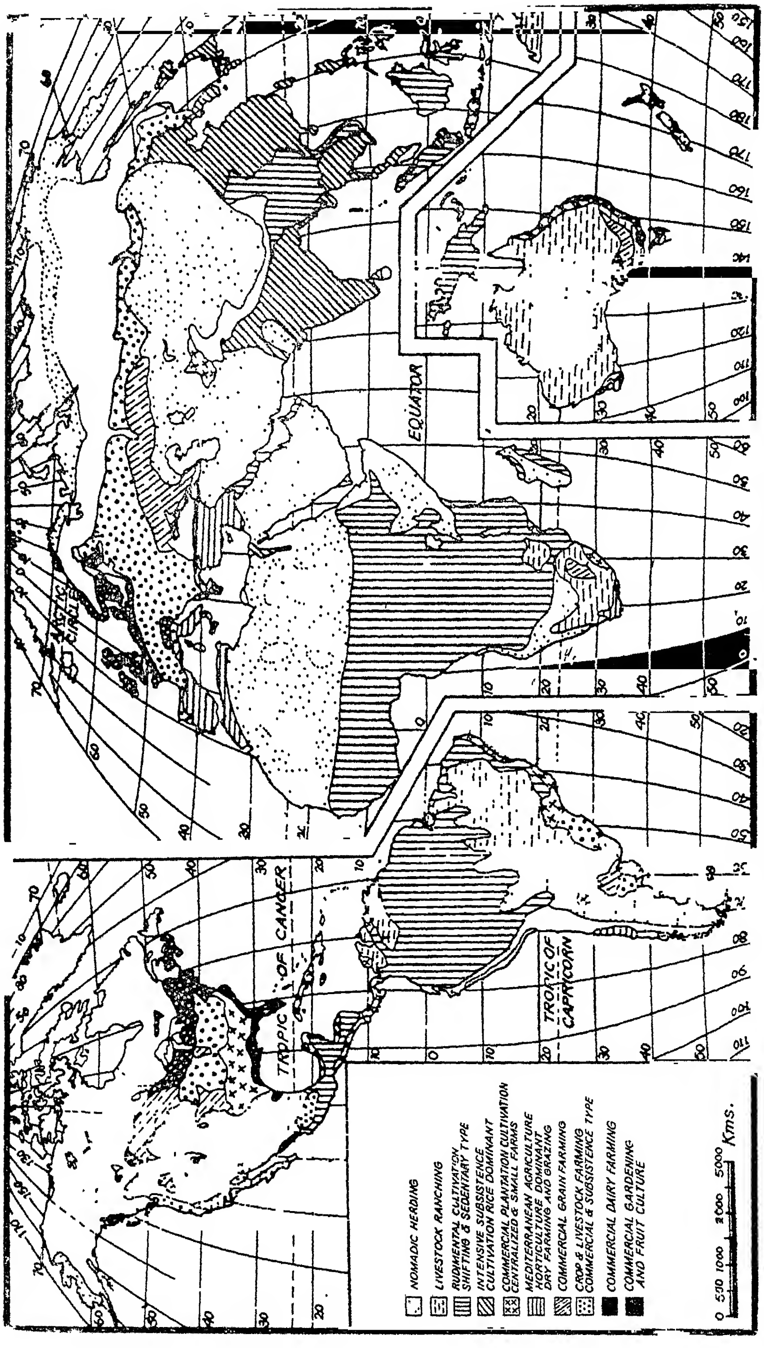


Fig. 25·1. Whittleseys Agriculrural Regions.

1. Nomadic herding

Nomadism is the practice among certain primitive peoples of Africo-Asian countries who frequently changing their habitation : especially applied to inhabitants of the Asiatic steppes and deserts, who wander in search of pastures for their livestock, or food such as fruit and roots for themselves, or possibly, for trade. Such people are known as nomads. Nomadic herding is mostly confined in the extensive dry lands of Central Asia, the Middle East, and North Africa. The economic form is likewise common to the Arctic ocean borderlands. But the Eskimos economy is more stable and productive than the Bedouins of Arab, who forced to raid their settled agricultural neighbours when food is scarce.

2. Livestock Ranching

In the extensive dry temperate grasslands, once roamed by nomadic herdmen or by hunters, are found permanent livestock ranches where large numbers of cattle, sheep, goals, camels and horses are kept. According to Whittlesey livestock ranching is not only confined to the northern temperate grasslands, but it is also practised to some extent in the tropical region of South America and Australia. Livestock ranching is most important in dry parts of Australia, Newzealand, South Africa, South America and North western north America. This type of activity is also found north of Caspian Sea in the U. S. S. R.

3. Shifting Cultivation

This type of agriculture is characterized by the use of crude techniques and rudimentary implements to produce goods intended primarily of solely for the use of the cultivator and his kinship group. This is also known as rudimentary cultivation. Rudimentary cultivation is mostly found in extensive parts of Africa and South America and Burma to Southern China.

4. Intensive Subsistence Cultivation

This type of agriculture is found mainly in south and South-eastern Asian countries especially in monsoon regions—on red and alluvium soils. It is found in all categories of landforms, although best developed where well-drained flat alluvial tract exists. Its growing season is free of frost except in higher elevations. Rice is most important agricultural crop of this region.

5. Commercial Plantation Agriculture

Plantation is a very distinctive and especial type of tropical agriculture and is mostly confined in many parts of Asia especially in Java, Sumatra, Malaya etc. western Africa and south central north America. Important plantation crops are rubber, sugarcane, tea, cocoa, coffee, copra etc.

6. Mediterranean Agriculture

This type of agriculture experienced by the lands bordering the Mediterranean sea and also by other regions in both hemispheres,

situated in a similar environmental position, on the western sides of the continents, on the tropical margins of the intermediate or temperate region, and in approximately the latitude of the sub-tropical high pressure sys ems—between 30° and 40° North and south latitude. Besides the lands around the Mediterranean sea, other areas enjoying this type of cultivation are central California, central Chile, the Southern tip of South America and Africa and parts of S. W. and Southern Australia.

It is a typical agriculture which has acquired a high reputation for the abundance of fruit and flowers which it produces. Typical fruits are the grape, the olive, and the citrus fruits – orange, lemon and grape fruit.

7. Commercial Grain Farming

Commercial grain farming is mostly confined in Argentina, Uruguay, portions of New South Wales, South Africa, Soviet middle east and Great Plains of North America. This type of agricultural region is distinguished mainly by the crop produced and by the degree to which that crop enters into commercial markets, usually in world markets.

8. Crop and livestock farming

This type of agriculture is best developed under temperate and dry continental climates of northern hemisphere, where the growing seasons are comparatively long. This type of agriculture is carried on the Central European plain and east of Urals upto Lake Baykal. Nearly all these regions are influenced by the westerlies and hence experience rather somewhat slight rainfall in summer. Wheat and vine are grown towards the south. The crops which are most common are oats, barley, rye, flax, potatoes and other root-crops.

9. Commercial Dairy Farming

This type of agriculture is found on the western shores of Europe and vicinity of the Great lakes of North America, where the rainfall occurs at all seasons. Dairying is important occupation of the peoples. Most of the western European countries are pasture land devoted to cattle, and the whole agricultural region is noted for its butter and cheese. Cattle and poultry are reared, and butter and eggs exported in large quantities.

10. Commercial Gardening and Fruit Culture

This type of agriculture is confined mostly in southern states of North America especially in Florida, Texas, Arizona, California, Louisiana, Georgia etc. These states supply the needs of consumers in the United States and Canada and export little to other areas. Some fruits are also grown the bordering countries of the Mediterranean sea.

EARL B SHAW'S CLASSIFICATION

Shaw gives a lucid description of the world's agriculture based on Trewartha's world climatic regions. Shaw, making use of

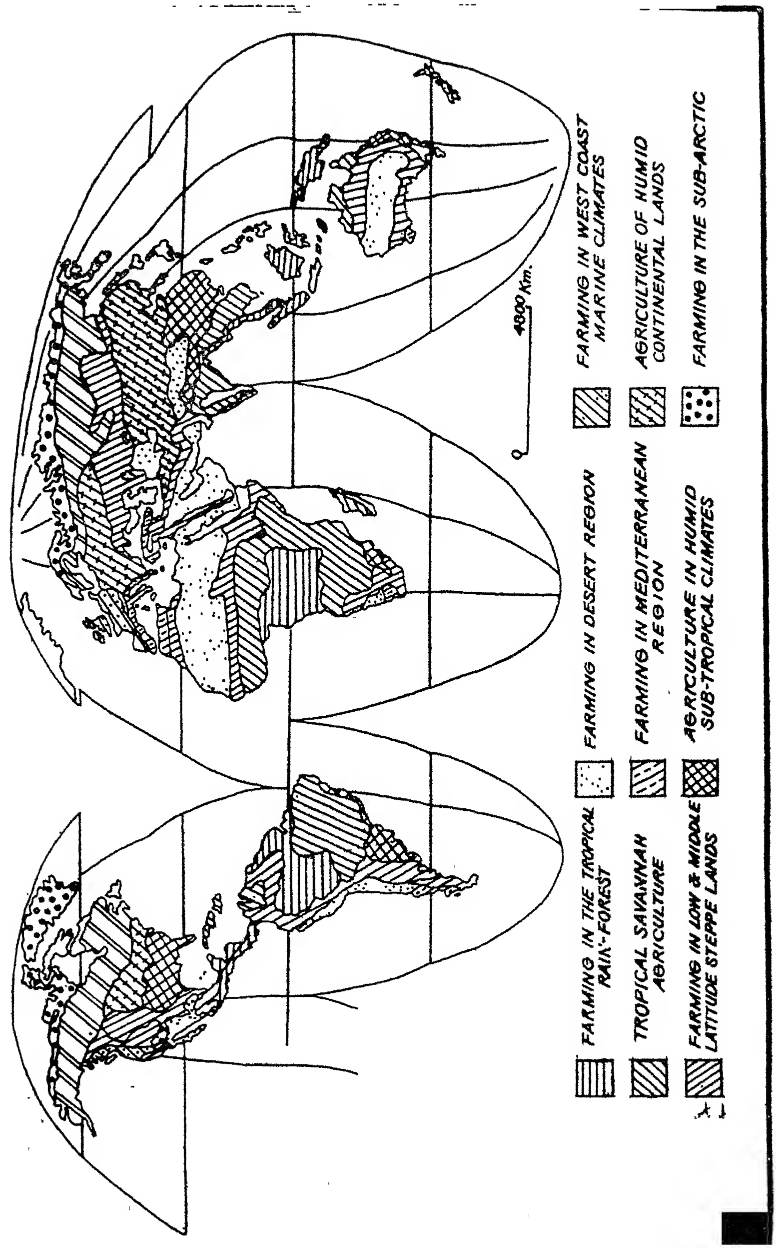


Fig. 25·2. Agricultural Regions by Shaw.

Trewartha's climatic classification, has converted into Nine agricultural regions. Location, climate, soil and landforms are the characteristic criteria of Shaw's agricultural regions. His classification is based on "geographic principles within regional framework". According to Shaw "an examination of world regions with an emphasis on farming gives opportunity to earn major sub-divisions of the earth as well as the geography of crop and livestock raising."

"What basis shall be chosen to divide the earth into regions ?" A good many as possible, but the climatic boundary line is extremely important in defining limits for most world crops and domestic animals. In view of this importance, the climatic base will be used.

"The basic philosophy of stressing principles were not be changed ; nor will there be any departure in following the general outline of *where can*, *where are*, *why are*, and *how are*. These major themes, and other, minor ones, will be employed in each of the world's major climatic regions from the standpoint of agricultural production, distribution and consumption. Before studying the geonomics of regional farming, however, brief attention will be focused upon location, boundaries, climate, vegetation, soils, and landforms. With this briefing on physical background, the student may be better prepared for an analysis of the agricultural pattern "* His classification is partly based on geographical location. Shaw has suggested the following agricultural regions of the world.

1. Farming in the Tropical Rainfall

This type of Agriculture is found mainly in Tropical rain forest of Amazon basin, the Congo basin, the Guinea coast, part of Indonesia and East Indian archipelago and the coastal lowlands of Briazil. Monoculture, or crop specialization, is the rule. Sugar cane was the first plantation crop to achieve commercial significance, but now at least a dozen more appear on world markets. Cocoa is a typical commercial crop of the tropical rainforest agricultural region. Production of coffee, oil palm, coconuts and the fiber crops, abaca, sisal etc. all important in world commerce, comes almost entirely from this agricultural region. His agricultural region is given in fig. 25·2.

2. Tropical Savanna Agricultural region

This agricultural region is flanked by the tropical grass-lands, called Savanna, where trees often occur in clumps, and along the river courses. Major portions of Savanna according to Shaw extend from about 5° to 15° on both sides of the equator. But Asian tropical Savanna agricultural region continue beyond India into Burma, Thailand and Indochina. Tropical Savanna agricultural region contributes millest, sesamum, cotton, sugarcane, and peanuts but cattle raising is also important occupation. Sugarcane and coffee are commercial crops of this region.

* Shaw, Earl B.-World Economic Geog. pp. 231-477.

3. Farming in Low and Middle-Latitude steppe Lands

This type of agriculture is found in every continent except northern and southern pole regions. In Russia, Asia and Europe a narrow zone is under this type of agriculture. In north America the steppe merges into desert as it extends westward. Rainfall is likely to show considerable variation from place to place and from year to year. All the steppes are the home of pastoral nomadism. Grazing of domestic animals, sheep, goats, and cattle, is the most widespread occupation of the steppe lands. Raising of beef cattle is also important. Wheat, beet sugar are a major world crops.

4. Desert Farming

The desert farming lie within 5° of the equator in South America. But they extend to 50° N. in Asia to 50° S. in South America. From the Atlantic coast of Africa near the tropic of Cancer, they reach across the continent into Asia's Arabia, Iran Afghanistan and Pakistan. Irrigation agriculture is practised on oases. Alfalfa, millets and coarse crops are mostly grown. Dates is commercial crop of desert farming. Nomadic herding occurs over huge areas. Caravans still provide an important means of desert transport.

5. Farming in Mediterranean Climates

This type of farming is found on west sides of continental masses, in southern California, middle Chile southwest Africa, west facing portions of Australia's southern coast, and most coasts bordering the Mediterranean sea Diversification is the mean characteistic features of Mediterranean agriculture but it is all subsistence type. A wide variety of commercial and subsistence crops are grown. Olive figs, Grapes and Citrus fruits are important. Wheat is also grown.

6. Agriculture in Humid Subtropical Climates

This type of agriculture is mostly confined in India, China, Japan, on the tip of Korean peninsula, Thailand, South, Africa, south eastern Australia, Brazil, Argentina, Uruguay and south portions of north America.

Rice is the most important crop of this agricultural region. This is one of the world great foods and supports more people than any other crop. The method of agriculture is most crude. Topsoil is worked by plow or spade. Cotton, another important commodity of the humid sub tropical agricultural region. Sugarcane is commercial crop. Tea is mostly grown on higher elevations. Its cultivation is mostly confined in India, China and Japan.

7. Farming in West Coast Marine Climates

Regions of west coast marine climates are found in western coastal region of North America, southern Chile, southern Africa, western Europe and England, New Zealand and Tasmania. Western Europe has the largest area, which includes northern Spain, Belgium, the Netherlands, Denmark, western Germany southw-estern coastal areas of Norway, British isles and all of France except the

Alpine section and the Mediterranean lands. Dairying is an important industry, especially in the countries of Denmark and the Netherlands. Dairying industry is an important farming element in almost the whole of the western European region. Beet sugar and potato production are other important crops. In New Zealand year round grazing favours sheep raising. As a matter of fact, New Zealand normally leads the world in export of mutton and wool.

8. The Agriculture of Humid Continental Lands

This type of agriculture is mostly confined between 40° to 45°N. Latitudes in north America, Urasia and Manchuria and northern tip of Honshu. In north America this region is known as 'Commercial Corn Mixed Farming' region. Corn does well where high temperatures continue through the night as well as through the daylight period. The spring wheat belt of the United States and Canada is also situated in this agricultural region. In Urasia the Russian wheat belt extends along the wetter northern part of the steppe climate and the drier southern portion of the humid continental short summer type. Beet sugar and oats are mostly grown in Urasian region. Dairying and raising live-stock for meat supply is dominant practice.

9. Farming in the Sub arctic

This type of agriculture is mostly found in extensive northern belt of North America and Asia, extending from the Pacific to the Atlantic in new and old worldand from north sea and North Atlantic to Pacific in Eurasia. The subarctic agriculture region has several outstanding characteristics. Probably the most distinctive feature is (a) the occurrence of long, cold winters, this more than (b) the short summers accounts for (c) the greatest temperature range of any of the world's climates. The growing season is very short so that only one crop is grown *Durand*--a frost resistant variety of wheat is grown in Alaska and Canada. Oats, rye, barley and in some river valleys small amount of spring wheat is important crop of this agricultural region.

TENTATIVE AGRICULTURAL REGIONS

The following is a tentative scheme which is desired to be placed before the academic world in the hope that they will favour publicly or privately, with their criticism.

A complete classification of major agricultural regions of the world not only shows the distribution of crops, animals, rainfall, soil and other socio-economic data, but it also explains the relationship between these factors in such a way that it is possible to trace major influences which have shaped the pattern of agriculture and which will indicate the path of future agricultural development.

What basis shall be chosen to divide the earth into various agricultural regions ?

Any classification of the agricultural regions must be based upon the following criteria :

1. Crops combination regions,
2. Especialization in agricultural production,
3. Intensity of land utilization in different crops,
4. Productivity and economic value of land,
5. Methods and techniques used in agriculture.
6. Type of production and trade value of crops.

A agricultural region should have a certain unity of terrain, climate, soil, vegetation and agricultural production.

The geographical factors like terrain, climate and soil also play a decisive role in determining the agricultural regions of the world. Climate is main controlling factor in crop production, because climate localizes the growth of plant and animal products, and to a great extent decides the nature of the manufactured goods required in exchange. We propose now to examine some of the principal features of the relations which exist between climate and various agricultural crops under natural conditions, to indicate their effects to decide the agricultural regions.

A very important aspect of climatology is the Agro-meteorological requirement for study of crop relations, optimum land utilization, crop patterning and protection from plant pests and diseases. And significantly, economists, planners and administrators need advance information, especially on probable occurrences of prolonged deficiencies in rainfall, droughts and their impact on food production. The recent agricultural famine over vast tracts of some of the countries aroused deep concern over the nature and distribution of droughts and their possible recurrence. The growth of agricultural crops are controlled by climate. Temperature, rainfall and sunshine are elementary requirements for its growth. Man can draw upon only particular types of plants for his food. These are generally grasses, though certain trees—fruit and beverage trees like mango, apple, cocoa, walnut—are also useful in this respect. Special types of crops require special types of climate and soil. It must be noted here that soil itself is a product of climate. The introduction of cultivated crops to supply man's food and other requirements mark a stage in the development of man which is made possibly only through cooperation with climatic laws. Wheat for instance, requires a particular type of temperature and a certain amount of rainfall for its successful growth. Man, therefore, selects the best season and time for crops growth when such temperature and rainfall are provided by nature.

In one respect man has been able to provide artificially a climatic requirement of agricultural crops, and that is in respect of

water. Man is able to provide water to cultivated crops in certain areas by artificial irrigation. But even here he is not entirely independent of climate. For the supply of water that he transfers from a river to a canal (technological development) and then to the field depends upon rainfall or snowfall.

In extending agricultural on the earth's surface, man must, therefore, take help from climate. According to Semple, "The effect of climate upon plant and animal life is obvious, and immediately raises the assumption that man has been similarly influenced". Subject to these environmental limitations, it is still possible to establish certain quite simple relations between climate and plant life, and it is remarkable how closely the relation holds with regard to the two climatic elements, temperature and rainfall. Moisture and warmth are essential to all that life upon which human existence depends. Hence temperature and rainfall are together the most important natural assets of a country, because of the influence upon its productivity of crops.

The grazing capacity and wheat yield of Southern Australia increase almost regularly with every added centimetre of rainfall. Raw wool is supplied from sheep who must graze on grass. The growth of grass, as has been mentioned previously depends directly upon climate. In colder climates, the sheep grow finer wool than in warm climates. In other to protect the sheep from cold, nature provides longer and finer wool on sheep skin than is necessary in hot countries.

Even in the age of science, most of our domesticated plants have been selected in response to the needs of specific climatic conditions. This is the reason why many of our former crop varieties were season bound, i e., they will flower and bear fruits only during specific seasons. Consciously or unconsciously even today the cultivators had chosen crops to fit seasonal patterns of sunlight, temperature and rainfall. If a plant has to give good yields ; it should gain more energy through the utilization of sunlight than what it would lose through respiration There has, therefore, to be an adjustment between crop morphology and physiology and the duration and intensity of sunlight and the variations in temperature.

Disease and pest epidemics can be better understood and avoided if we have a good knowledge of the climatic factors influencing their multiplication and spread. High humidity fosters the build up of disease organisms. If there is rain during an unusual period, some of the alternate hosts of pests may destroy standing crops.

Economic factors are not definite like physical ones and change from time to time. With in the limis, set by physical factors, the choice of farming can be determined.

Marketing cost all over the world is one of the most important factors affecting the agricultural regions. In Mediterranean slopes,

there are excellent areas where fruit, cultivation can be taken, but the cost of transportation in some localities are so great that fruit growing on commercial line is a prohibitive proposition. Sugarcane is generally grown round the densely populated tropical regions of Java and Cuba. The sugarcane factories are located close to the cane fields since cane—the raw material—are a bulky, heavy low valued commodity that is limited to a relatively short haul by transportation costs. Cost would increase in proportion to the distance from the farmers fields.

Availability of labour and capital is another factor determining the type of agricultural regions of the world. Crops which give the largest relative profit predominate any farming programme. In Bangladesh the physical factors such as soil and climate are suitable for growing both sugarcane and Jute. But the relative income from Jute is such that the sugarcane farming enterprise has considerably dropped.

Changes in relative value of farm products affect the types of agriculture in a given locality. The old cotton belt of U. S. A., only for example, has disappeared. A century ago the cotton growing areas of the U. S. A. were located more solidly within the states bordering and east of the Mississippi river. Soil erosion and deplation, together with much plagues as that of the *boll weevil* in the early 1920's, were partially responsible for a decline in parts of the east and south—more specifically, in the Atlantic Coastal Plain, the Souther Piedmont and the well known belt of black, calcareous soils of Central Alabama and North Eastern Mississippi. At about the same time, the crop was introduced into north central Texas and South Western Oklahoma, where the Prairie soils were naturally more fertile and the drier climates discouraged the boll weevil.

During the World War II, the prices of food grains increased very high with the result of this there was considerable shrinkage of cotton area all over the world. In Argentina and Uruguay maize area has gone up at the cost of wheat area due to a great variation in the relative price of the two commodities. Land values also affect type of agricultural regions to a certain extent. Near all the metropolitan centres the value of Land is very high and so it has a high cost of interest. In such a land vegetables and kitchen garden crops are mostly grown and very intensive type of agriculture is followed to get a very high return per unit of land.

The personal likes and dislikes of an individual may, in isolated cases, affect the type of agriculture. Consumers demand of a certain market may cause minor change within the general farming system followed in locality. The demand of potato and meat during world war II influence the cropping system of United Kingdom.*

* Stamp, L. D—The Land of Britain—its use and misuse, p. 309.

Social factors also play a part in determining the agricultural regions of the world. In case of England, according to Stamp, "it is often said that a lower standard of living in many western districts in itself an encouragement to grassland farming, since the standard of living in question can be satisfied from a small grass farm worked with family labour, whereas arable farming might require more capital and would generally involve the use of hired labour."* Social factors are not definite like physical one and change from time to time.

Ecological influences are exclusively indirect but, paradoxically, are even more important in the distribution pattern of man's crops. Therefore, weather conditions such as rainfall and its distribution, temperature and day length and growing-season and technological development, fertility of soil have a marked influence on the growth as well as on the yield, and these factors determine where and to what extent the crop can be grown and ultimately divided the earth's surface into various agricultural regions.

This chapter does not indulge in the analysis of the methodology of crop combinations. It simply attempts to group all major crops and thereby delineate patterns of crop associations. The method is very simple and it only takes into consideration percentages of crop area to the total cropped area of various countries. Such a study is very essential and useful for demarcating more complicated structure of agricultural regions of the world. According to this simple method used in this work the whole countries of the world is divided according to the principal production specialization (wheat, rice, rye, oats etc.) on the basis of similarity of production. In the division the author proceeded both from the natural and from the socio-economic conditions. Those regions were characterized by their specialization and specifie conditions of production. These regions were grouped into eight agricultural production regions. This division found wide practical application. Considering the different physical, socio and economic factors the earth's surface can broadly be divided into the following agricultural regions. They are :

1. Region of Plantation Agriculture,
2. Rice, Tea and Jute Agricultural Region,
3. Commercial Grain Region,
4. Mixed Farming Region,
5. Fruit Farming Region,
6. Commercial Livestock Farming Region,
7. Commercial Dairy Farming Region,
8. Region of Nomadic herding.

Fig. 25·3 shows the important agricultural regions of the world.

Major Agricultural Regions of the world :

* Ibid.

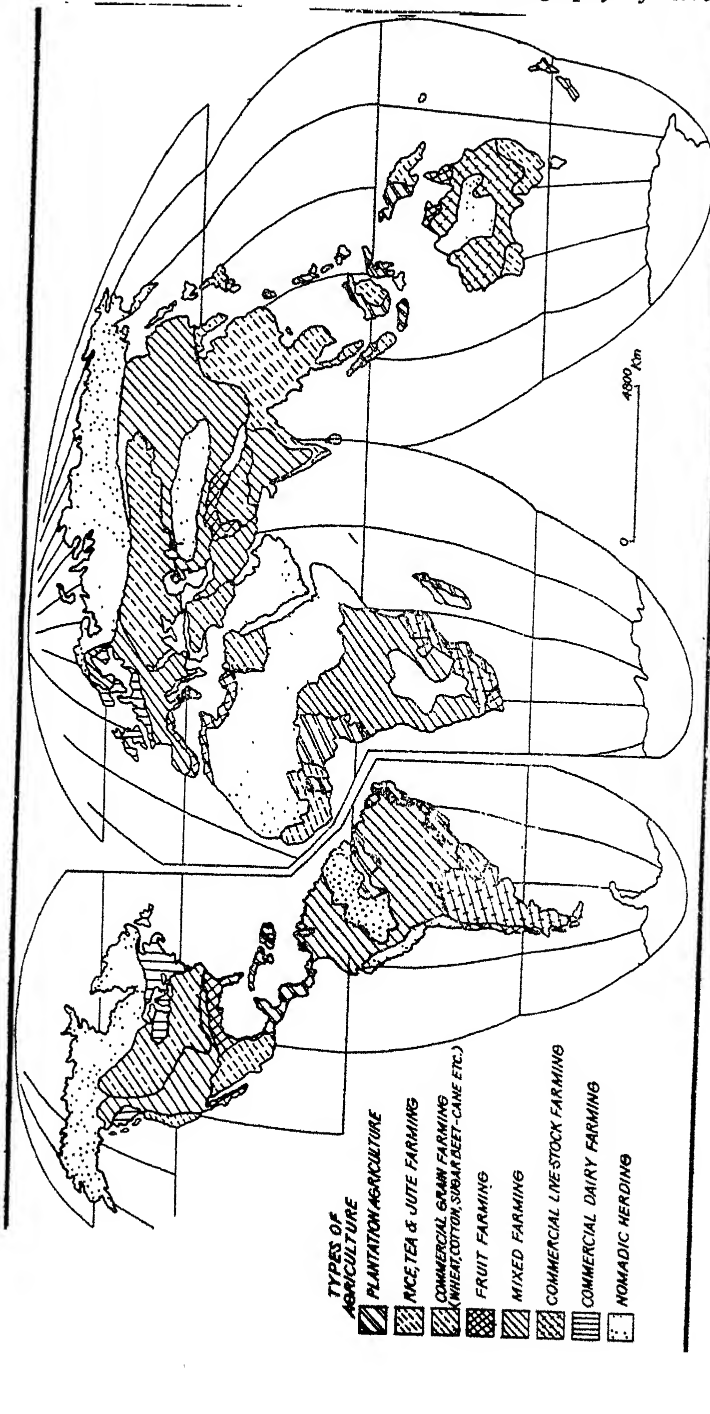


Fig. 25·3. Tentative Agricultural Regions

REGION OF PLANTATION AGRICULTURE

The specialized commercial agriculture of cash crops especially plantations is a very distinctive type of tropical cultivation and is found in many parts of tropical and sub-tropical parts of the earth. This type of agriculture is best developed under tropical and sub-tropical climates, where the growing seasons are long. The majority of the world's plantation regions are in the low latitudes, only a few are poleward of the Tropic of Cancer or the Tropic of Capricorn. Notably in the south-eastern United States, however, this type of agriculture extends conspicuously but erratically as far north as lat. 35°. Here, on account of latitude and oceanic influences, the range of temperature is slight, and the average temperature is high, but moderated by altitude in many parts. The rainfall is heavy and occurs at all seasons, though it is generally heaviest about the period when the sun it is highest in horizon. The countries are well supplied with forests, and yield such products as coconut, sago, rubber, yam, cassava, ground-nuts, abacca, sisal, banana, tamarind, ginger and various species. Forests cover a large part of the East Indian archipelago, and coconut palms fringe the shores. Not only are the coconuts exported in a natural condition, but the dried Kernels, called Copra, and the extracted coconut oil are also articles of trade. The fibre of the husks also is exported for the manufacture of ropes and matting, and mats are locally made from the palm-leaves. Tea has nearly supplemented the coffee plantations, while cocoa and rubber plantations are increasing on the lower slopes.

The bulk of the present population of plantation regions of South East Asian countries consist of settlers from Europe and their descendants ; but Chinese coolies are found in some parts, through their entrance is now rendered very difficult by various restrictions. The number of natives was much reduced by frays with the early white settlers. They are now confined within certain reservations or found in the less fertile and accessible parts of plantation agricultural regions. None now exist in Java. Some of the main plantation crops are cotton, sugarcane, rubber, oil palm, copra ; beverages like coffee, tea and cocoa, fruits like pineapple, bananas as well as hemp. etc.

In Western Africa where plantation agriculture is mostly confined in small holdings by irrigation. In the tropics, with varying rainfall, irrigation is successfully employed to bridge over the marked dry periods for crops with a long growing period or for tree and bush crops—for example, in the cultivation of sugarcane in Uganda or of cocoa in Zaire. It is significant with a view that the productivity of land is based on the availability of amount of irrigation water.

Plantations are basically an agricultural industry and in colonial areas, where the dominant industry is agriculture, it should naturally form a part of agriculture and the only reason why it is

looked upon as an industry by itself, apart and distinct from agriculture in some tropical countries, is because, while agriculture is moving in the traditional rut, over most part of the colonial areas, and has degenerated into fragmentations of the worst type and subject to the most abnoxious vices of under-capitalisation inspite of the much boosted cooperative movement, the essential basis of plantation agriculture is its large scale exploitation to which agricultural holdings do not land themselves.

As a matter of fact, plantation agriculture in its proper form, cannot be conceived of except on a large scale so as to admit of modern concepts of personnel management and commercial exploitation, financial administration to be applied to the fullest extent as in any other large organised industry. Any way plantation claim to be the earliest and the largest employer of labour. The labour tends to be done by either hired workers or tenants. Agricultural methods and tools tend to be more technically advanced than in most smaller farming operation. The classification of regions of plantation agriculture is based, therefore, upon the size of holding, mode of ownership, mode of operation and degree of commercialization.

The produce consumer commodities for home consumption and exports of such a large scale that the total value of such exports exceeds that of any other commodity. In this highly commercial type of agriculture, specialization of both labour and harvested crops usually exists, and most of the crops are sold in the world markets. The main characteristic features of plantation agriculture are foreign ownership and local labour, heavy capital outlay, small holdings and estate farming which is managed scientifically.

RICE, TEA AND JUTE AGRICULTURAL REGION

The second agricultural region is rice, tea and jute region, where extremely poor agricultural conditions exist as in India, Pakistan, Bangladesh and South eastern Asian Countries, the majorty of population is living on subsistence agriculture, further depressed by high population density. Here are the areas of the lowest and worst economic conditions in the world, referred to as the "pole of hunger." Other developing agricultural areas like west Africa, Uganda and central America are less densely populated and their economy is based partly on subsistence or commercial subsistence agriculture. Nearly all these regions are influenced by the monsoons and hence experience rather pronounced summer rain and winter drought conditions, although the winters are moist in eastern coast of India, Japan and southern China. Occasionally a moisture deficiency occurs in summer, especially in northern China and in India, sometime causing crops failure and famine. Because of high population density, all usable land is cultivated. Rice dominates the landscape as also the outlook of the people. This need for growing rice in this region wherever possible, leaves very little land for commercial crops.

The most dominant character of agriculture in this region is

that there are only a few crops grown over large areas. The number of crops grown is not large. Rice, Jute and tea are the outstanding crops. Jute tea and rice are sold in international markets. Oil seeds, cotton and Sugarcane are other important crops of this agricultural region. The climatic conditions, as well as the large population pressure to be fed, naturally make rice the most widespread crop of the region. The region is occupied by the lowest ends of several rivers and naturally, therefore, comprises of low ground. River banks and depressions are the two most important physical features of the area Composed mostly of the alluvial soils brought down by the rivers, this region has a high agricultural value, except in the lower delta of the Ganga and Brahamputra. With few exception, irrigation plays the least part in the agricultural operations of this region. Except in China, irrigation canals and tanks are almost unknown in this region. Whenever there are long breaks in the monsoon rains, some irrigation by lifting water from the numerous depressions, which have almost always some water, is practised As manuring is not common in rice cultivation, and as rice is the most widespread crop, the use of manures is not important in this region. The annual floods, in fact, supply such large quantities of new fertile silt every year to the fields that soil naturally recoups its fertility without any manure. In tea plantations, however, the use of manure is common

Burma, Thailand, Cambodia and Vietnam are the important rice exporter countries of the world and known as "Rice Bowl" of Asia. The rice is planted is small and medium sized fields, the paddy fields, which are rarely larger than half an hectare. The cultivation system is the same as that employed throughout southern Asia :

(1) the seed is placed in a specially prepared and carefully irrigated bed to produce the seedlings;

(2) the actual rice fields are prepared by levelling and working the soil which is covered with water, if possible by using draught animals. This is the "mudding" process which is intended to produce the greatest possible homogeneity of the top soil in which;

(3) the seedlings are planted after two months germination ;

(4) the plants are harvested with a sickle, cutting the stems at the lower third part of their length;

(5) threshing is done mostly by hand, either by beating bunches of corners on a sloping board or by using a bat to increase the striking power. This bat consists of two roads tied at the top with a cord which then wraps round the bunch of ears, increasing the length of the swing during the beating process. In Indo Pak continent, rice is cut from the root and stored on the field in stacks with the ears inwares. There it is left for four or five days to dry, and after that the grain is trodden out by foot

simply by men or women on mats. The stalks are made up in bundles and stored round a pole or in the fork of a tree and afford food for cattle and bedding for the poor. The grain is taken home, and, after being dried on the roof of the house or on courtyard, is storted for use in boxes or in bags or in baskets plastered with mud or cow-dug. Unhusked rice is known as '*dhan*', and before husking it is again dried in the sun and then pounded in a stone mortor. The pestle in is tipped with iron and the grain is pounded three different times before the clean rice of *chawal* is produced. The chaff is used as fodder for cattle.

This is a region of intensive subsistence agriculture which is concentrated in south and south eastern Asia, were it covers most of the cultivated land. Intensive subsistence agriculture is mostly confined in India, Communist China, Japan, Pakistan, Bangladesh, Burma, South Korea, Thailand, Cambodia and Vietnam. A few comparatively tiny representations of this type of agriculture are found in western Africa and central America.

Owing to the large agricultural population in relation to the area fit for cultivation the fields are generally very small in this region but large amount of land actually cultivated. India alone contains nearly one-sixth of the world's total cultivated land, and People's Republic of China an additional one-twelfth.

These fields are cultivated with the help of bullocks, the use of agricultural machinery being almost unknown here. Most agricultural operations are done by hand labour which is a characteristic feature of all rice lands. The stagnant water in the depression and in the rice fields breeds mosquitos which saps the health of the agricultural labourers and agricultural labour is, therefore, not very efficient here.

Weeds are very common in the fields here. A very serious problem facing agriculture in some parts of this agricultural region, especially, in Bangladesh and Northen Thailand is the spread of the *water Hyacinth.* This weed takes root in the stagnant water and is difficult to eradicate. It completely chokes any crop growning in such water, and thus makes large areas formerly good agricultural land, unfit for crop cultivation. In the flooded areas where rice is cultivated we find another important economic activity : fishing. As major supplies of protein fish have particular importance in the diet of the rich-growing countries. They supplement the diet and play a decisive part in mantaining the health of the population. So large quantities of fish are bred in the individual rice fields and caught more or less by traditional methods. The most commonly used is the flat rectangular net strung along a raised beam and supported by bamboo props. It is dipped into the smooth water and after a while lifted out, bringing with it not only the small fish but also the algae which are full of protein and are, of course, used as well. When the rice fields are cropped and

drained, the fish hide in the mud and survive the dry season under a hard and often even a concrete like top-soil interlaced with cracks. In the larger rivers, backwaters of the Mae-Nam Ping, the peasants establish real fish nurseries where they cultivate and look after the spawn so that they can fall back on them whenever necessary. The fresh water fish-breeding programme is assisted by the various governments and government agencies. There is some peculiar system of cultivation in backward and tribal areas of this region. This system is known as shifting or *Jhuming*. *Jhuming* is practised only between certain altitudes in North East Frontier Agency, Southern China and North Eastern Burma. During the hot weather, the debris is set fire to at the lowest part of hills, the rising flames cause an upward draught and fire rushes up the hill. When all is over, nothing is left but the charred and blackened trunks of the largest trees. As soon as the embers have cooled down, various seeds, such as rice, millet, *Jowar*, pumpkins etc. are dribbled into the earth with the ashes. The hill slopes are weeded once or twice during the rains before the crop is harvested. Next year and the following year the field is cultivated and then when the accumulated fertility of the soil has become exhausted, mainly through exposure and erosion, the area is abandoned for two to three years. A distinctive shrubby vegetation then takes possession of the land, or it may be covered with a weed. In areas where there is a real land hunger, the *Jhumias* return at shorter intervals to the same hill slope and the inevitable result is that the area does not get a chance to become covered with vegetation at all.

The most important commercial crop of this agricultural region is jute. Jute is an annual sown in spring and cut when about 4 metre high. The stems are then submerged in water for at least three weeks, after which the bark can be removed and the fibre separated by mashing and beating. The fibre is used for making sackcloth, and also in the manufacture of carpets and various textiles. Tea is second important commercial crop. The countries which produce the most tea are Japan, China, India and Ceylon or Sri Lanka.

The characteristic features of this agricultural region may be summarized as follows—The holding is small. Farming is very intensive and human labour is mostly used. This is multi-cropping region and the farmers make use of every available type of manures including farms wastes, rotten vegetables, animal dung and human excreta.

COMMERCIA GRAIN AGRICULTURAL REGION

The commercial grain agricultural regions are prominent in the middle latitudes of central and western North America and extensive belt of Urasia, and appear in patches in the middle latitudes of South American and Australia.

The climate of this agricultural region can be broadly descri-

bed as temperate, equable, remarkably mild in winter for the latitude, and liable to a fair rainfall at all seasons. Near the coasts and in mountainous parts, the fall is often excessive. This area was originally covered chiefly by forests; and though these have been cut down in the great plains to make room for crops. Ordinarily, the rainfall in this agricultural region is neither too much nor too tittle for agricultural purposes. The seasonal character of the rainfall distribution, however, makes irrigation an integral part of the agriculture of this region. There is a clearly marked rhythm in the winter and summer temperatures. The winters are cool, while the summers are hot. Irrigation is, however, confined entirely to wintr crops which are grown when the season is characteristically dry. In Indo-Pak continent and Australia wells predominate in the irrigation of this area. Commercial grain agriculture involves the utilization of heavy machines, much land, and few people. Consequently, it is usually found where populations tend to be sparse, except in such areas as in Argentina, Uruguay and the Soviet Union, where commercial grain agriculture farming overlaps other productive activities, particularly manufacturing.

Commercial grain farms are large, financed by high capital investment specialized as to crops produced and centrally managed. An important feature of the agriculture of this region is the multiplicity of crops grown here. There is hardly any other part of the world where the variety of crops grown is so great as it is in this agricultural region. This multiplicity of crops depends, of course, on the absence of extremes in agricultural conditions There are moderately varying conditions of rainfall, temperature and soils which enable a large number of crops with varying requirements to be grown in this region. Considerable use of manures is another important feature of the agriculture of this region. The importance of wheat and sugar beet in northern latitudes and cane-sugar in sub-tropical region which need considerable nutrition from the soil in order to yield well, makes the use of manures incumbent chemical fertilizers are mostly used in western and technically advanced countries while in old world manure consists largely of the animal refuse and domestic refuse. In Asian countries, the large number of animals found in this regions is, thus, a great help in providing animal manure. As a matter of fact a large amount of cow-dung is used as a domestic fuel in a region where the demands on soil fertility are so great is a great agricultural drawback. Cow-dung is valuable manure in developing countries. Its use for any other purpose, therefore, deprives the soil of a source of fertility.

Wheat is outstanding among crops grown in commercial grain agricultural region. Others of the small grains especially oats and barley are noteworthy and where there is ready access to cheap transportation, corn is produced. There are distinct areas in which these crops predominate ; as for example, spring wheat dominates

in Canadian Prairies to South Dakota, winter wheat in south of spring wheat in N. America and from Ukraine to Bakayal in Russia, corn in South Eastern estates of North America and beet sugar in the middle section of this region. These crops occupy generally the best land. The enferior soils are given over to the cultivation of poorer crops like oats, rye, barley and millets etc.

The occurrence of large areas of pastures, especially in the lowlands near the numerous rivers, enables a large number of cattle and other animals to be kept. Most of the cattle in developing countries are meant for agricultural operations while in developed countries for mutton. Dairying is, however, being encouraged in the neighbourhood of large cities. The presence of large towns has offered an incentive for growing fruits and vegetables in this region on a fairly large scale. Large quantities of potatoes and cauliflowers are grown in the area around big cities in developed countries. These vegetables find ready profitable markets even in distant places. The size of farms in western countries are large and peasants are rich. Fields in this region are very small in old world. The agriculturists are generally very poor, due to the great preseure of population on land. The presence of the industrial and other towns, make it possible for the agriculturists of this region to supplement their income from agriculture by working in these nearby towns during the slack season when agricultural operations do not need them. The following are the chief characteristic features of this region: Wheat monoculture is important. With few exception, Farms are very large and cultivation is highly mechanized but yield per hectare is low.

FRUIT FARMING REGION

Fruit Farming region is found on continental western fringes generally between latitude 30° to 40° North and South. It is most extensive along the arable margins of the Mediterranean sea. The same type of agriculture is found in the California valley, middle, Chile, the Cape area of South Africa and southern Australia, where the climato-agricultural conditions are similar. Fruit farming region reflects Mediterranean climate.

The fruit farming region is very hot in summer, and fairly warm in winter, both on account of its southerly latitude, and of its being sheltered from cold winds from the north by the belt of ranges and plateau of central Europe. It enjoys also a large amount of sunshine, especially in the south and east, where the rainfall is very slight. The rainfall is heaviest on the western slopes. The rainfall occurs chiefly in winter, as it is only at that season that the westerly winds blow strongly over it. The rainfall varies considerably in amount in different parts.

Fruit farming region is also confined to California valley, where the summers are dry and the winter rainfall is scanty. Many streams of this region help to bring down the soil which has converted the valley into such a productive area. Much of the land of California is now devoted to producing wheat, grapes, oranges pru-

nes, peaches, apples, pears, and many other fruit. These products can be sent away by rail as well as by sea. Middle Chile has a warm climate and is characterised by winter rains and summer drought. The chief crops are wheat and barley, and such fruits as grapes and olives—productions, in fact, similar to those of the California valley in the United States. The Gulf region of America is famous for citrus fruits. Florida produces most of the nations limes, lemon production has become virtually a California monopoly. Grape fruit is mostly grown in Florida. Truck farming on the Atlantic plain is important.

Viticulture, horticulture and sericulture are well developed in Mediterranean lands of Europe so that these lands are known as the "Orchard lands of the world", and the heart of the world's wine industry. Fruit farming has long been a traditional Mediterranean occupation because of the very special climatic features in Mediterranean areas. The Mediterranean climate and landscape is very varied in different localities and this affects the emphasis on certain crops. Grapes are mostly grown in France, where wine-making is a national industry. Olives and figs are indigenous in Spain, Southern France and Italy. Orchard farming is not only located on lowlands but are found on terraced hill slopes, in piedmont region and on uplands around Mediterranean.

Citrus fruits mostly lemons, oranges, grapefruits figs, olive etc. which have long, wide spreading roots, scant foliage and fruits with thick skins are best adopted to the Mediterranean type of climate. In semi-arid regions in North Africa and in scattered areas, fruits are sometimes raised on unirrigated ground and draw their moisture supply from deep in the soil. The raisin has for centuries been an important crop and export from countries around the Mediterranean Basin. Turkey was long the world's leading exporter with Greece, Spain and Iran.

In the east, this type of agriculture is concentrated in Jammu and Kashmir, Himachal Pradesh and Hill districts of Uttar Pradesh, has low winter temperatures and only a single crop of vegetables and fruits can be grown from April to November. Short and medium duration varieties of crops are usually grown, as the crop mature before the onset of winter. The cultivation of fruits on the Himalayan slopes is a characteristic feature of the agriculture of this region. The cool weather crops consist of potatoes, barley etc. The showing of these crops starts here at the time when wheat is harvested in other parts of India. In whole fruit farming region, three different types of crops are found : grains, notably wheat, dominate the first category ; tree crops olives, dates, figs—together with drought resistant grapes, prevail in the second ; and a wide variety of garden vegetables and fruits make up the third.

In addition to producing crops, most fruit farming regions contain animals. Beef and beef-dairy cattle are found in California, Chile and Southern Europe. Grazing occurs principally in

sparsely populated lands having a shortage of moisture such as Iberian peninsula and Italy. As a rule the trees in these areas are scattered in small clumps and there is little rich pasture land. Many sheeps are reared on these pastures as well as bulls, horses and mules.

MIXED FARMING REGION

Mixed farming is mostly found in China, India, U.S.S.R., Europe, North America and many developed and developing nations of the world. Many farmers of developed and developing countries both grow crops and raise livestock. In developed countries, especially in U.S.A and Britain mixed farming is very intensive and sometimes highly specialized. In Asian and African countries this type of farming is still the major agricultural type. In the U.S S.R., U.S.A. and Canada some farms may be devoted entirely to arable farming or entirely to livestock, but traditionally farmers practice a truly mixed agriculture raising animals and growing crops. Mixed farming are moderate in size and usually grow crops such as wheat, maize, barley, oats, rye etc. according to the locality of the field, soils fertility, market demand and animal carrying capacity of the land. In U.S.A. and the U.S.S.R where mixed farming is the main type of agriculture, high capital expenditure on tractors, machinery and farm buildings are the chief characteristic features of this type of agriculture. Chemical fertilizers as well as green manure are extensively used in developed countries. Soil fertility is mostly maintained by the rotation of crops. Many peasants grow root crops like potatoes, legumes crops like peas, clover or beans, as an alternative to cereals in some years. Industrial crops like sugarbeet, tobacco, hops and flax are also grown widely. This type of farming is found most of the European countries.

Farming in most of Asian and African countries are neither a profession, nor a business or an industry, it is just away of life. The farmers have no alternative profession. The fact that a very large percentage of farmers are working on uneconomic holding is a proof of that. In developing countries, the size of the farms is so small (Fig. 25 4) that there is hardly sufficient work for the farmer and his family to be kept engaged all the year round. The bulk of the population is agricultural and agriculture here means ordinarily the growing, harvesting and disposal of two crops in the year. Agriculture of this kind involves very hard work for certain short period , that is generally two sowings, two harvestings and occasional weedings in rains and three waterings in cold weather and almost complete inactivity for the rest of the year. In precarious years inactivity may be unavoidable for a whole season. These periods of inactivity are in a great majority spent in idleness. Generally the human labour utilization ranges from six to eight months a year depending upon the type of farming and cropping scheme followed. In fertile tracts, the farmers grow commercial crops-tobacco, sugarbeet or cane, wheat as cash crops. In irrigated

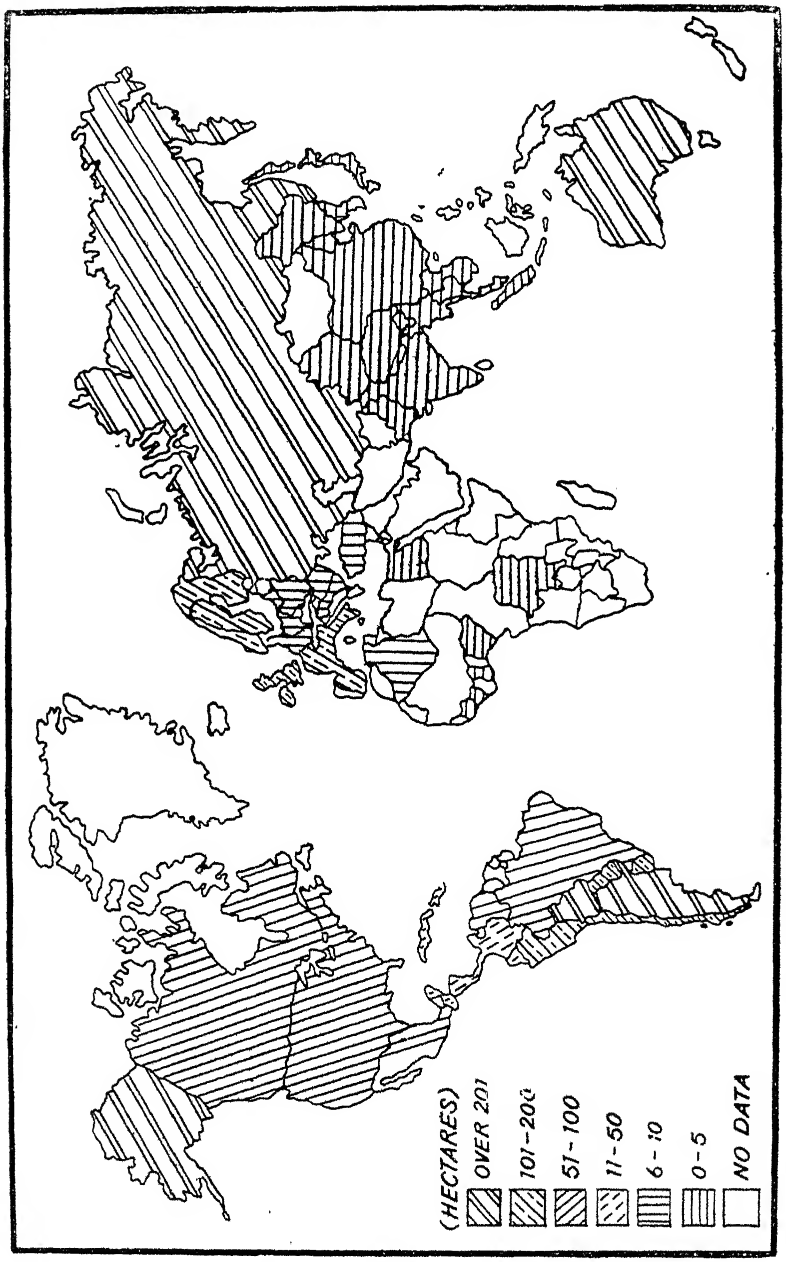


Fig. 25·4. Size of Farms

areas rice is important. Under this intensive cropping programme, the human labour utilization is worked out about ten months a year. But in most part of Asia where the following cropping scheme is followed, the results are quite different.

Coarse crops with mixed fodder	Rice	Cattle maintained
Transitional crops (mixed pulses)		One pair of bullocks and three to six cattle
Follow	Wheat	Cows or one buffalo generally.

The labour months utilization of the farmer and his family in the above mentioned cropping scheme and in looking after the cattle is calculated at seven months a year. For the rest of the year the family remains mostly idle.

Mixed farming is a combination of crop production with a significant amount of livestock raising. It refers to that type of diversified agriculture in which a farmer invariably devotes to livestock production as a complementary enterprise. The most important reason for mixed farming is that it has been necessary in most countries to permit the use of a system of crop rotations combined with live-stock enterprises for getting draught animals for cultivation and for maintaining and improving soil fertility.

For agriculture in Asia or Africa as a whole, mixed farming is the rule. It is the best available means of production to provide diversity of sources of income. Mixed farming offers the following advantages.

1. It tends to give a balanced labour load throughout the year for the farmer and his family.

2. It helps the maintenance of soil fertility. Crops cannot be grown successfully without the use of manures. The most readily available supply of plant food is farm-yard manure in developing countries. But, unfortunately, a large part of this in Asia or Africa is used as a fuel resulting from pressure of population on the land.

3. It permits a proper use of the farm by products. It provides greater chances for intensive cultivation.

Mixed farming, as practised today is a symbol of old agricultural civilization. But the condition of both the crops and live stock is unsatisfactory.

From the standpoint of land utilization the chief question to be decided in the country is whether the land could be more effectively used under a system of mixed farming. The answer of this question is largely dependent upon the n ature of the soil. In some countries farmers have discovered that the spread of leguminous plants consequent upon the use of amonium sulphate has so

improved the condition of the soil, both in fertility and structure as to make cropping with wheat a profitable practice, thus affording an instance of transition to "*ley farimng.*" Under the "*ley system of farming*" the land is put down under pasture plants for a series of months. Crops are then grown on it for one of more years, after which it is again put down to pasture. Leguminous plants are usually held to be an essential component of the pasture The benefits of the system are that it induces a better soil structure which gives easier cultivation and higher yields of grain per hectare.

COMMERCIAL DAIRY FARMING

In various parts of western Europe especially in Britain Belgium, the Netherlands, Southern Scandinavia, to the South of Great lakes and in the North Atlantic states of North America farmers specialize in commercial dairy farming, which is a highly intensive type of livestock farming. Climatic conditions are a major consideration for many countries of western Europe specializing in this type of production, particularly those where low temperatures, excessive moisture, or a short growing season prevent most field crops, such as the grains, from reaching a state of maturity adequate for use other than the feeding of milch cows. These conditions limiting grain production, however, are conducive to rich pastures and to high milk yields.

Location of market is also a influencing factor of this type of agriculture. Most of Benelux countries are pasture land devoted to cattle, and the country is noted for its butter and cheese. Cattle and poultry are reared, and butter and eggs exported in large quantities.

A little more than half a century ago each farmer in Denmark grew his own rye, oats and barley; reared a few horses and pigs, and kept some poultry. But gradually these Danish folk found that cereals from the New world and cattle from the Argentina were spoiling their markets. They realised that if they were to prosper they must adopt fresh methods. Marsh lands were drained, heather moors were deeply ploughed and planted, and by these means the land was made fertile. Prosperity came to the country.

The damp climate of Denmark is especially suitable for dairy farming, for this dampness in the air helps to produce rich grass. At the same time it is not too moist for such crops as oats, barley, rye and potatoes, all of which do well on sandy soils such as are found in many parts of the country.

Denmark is a butter house of Europe. It is from her dairy farms that Denmark obtains most of her wealth. Most of the farms are small, and the farmers own their land. Many of the houses consist of an oblong building; in one part live the family, and in the other the stock are housed. The cowsheds, pigsties and poultry houses are all scrupulously clean. The milk is sent to cooperative creameries where it is separated and churned into butter or made into cheese. The skin milk is taken back to the farm and used to feed the pigs. It is not surprising that Denmark is famed

for her dairy produce. England is her best customer, and each year she sends vast quantities of butter, eggs and bacon. Most commercial dairy Farming regions convert their surplus milk into other products, such as butter, cheese and condensed and powdered milk. Because milk is less perishable and bulky in these forms then in its original state, and can thus be transported greater distances, such products and areas difficult of access. This is the type of production prevailing in the Swiss and Austrian Alps, the mountains of Norway and the Lower St. Lawernce valley of North America.

COMMERCIAL LIVESTOCK FARMING

In the extensive temperate grasslands this type of agriculture are found mostly in Argentina, Uruguay, Australia and New Zealand. This type of agricultural region is defined principally on the basis of the variety, intermixture and commercial nature of its crop and animal products. Today, the primary economic activity of pampas are the production and sale of milk, wool and mutton. The main source of fodder for the cattle is the natural grassland of the low-lying areas and also the wooded lands. In addition, the main output of the cultivated areas is directed to the maintenance of the cattle. Millet, corn and alfalfa are harvested and used to improve the fodder situation specially in the winter. The stubble and the plots sown with clover and oats provide valuable artificial grazing for the animals. Occasionally, it is necessary to buy supplementary feedstuffs. The cattle are kept outside on the pasture land all the year round; there are no cowsheds. Milking is done by hand in a milking shed, to which cows are brought. Milk production runs at an average daily output of 160 litres. The only cash crops produced on the arable land are potatoes and melons; there are sold to dealers who buy the produce at the farm.

Besides the well-known Argentinian cattle breeding regions of the Pampa, Entre Rios and Patagonia, the Gran Chaco region in the north, situated between the mountains and the Rio Paraguay Parana can be called a cattle breeding area of particular character.

There are marked differences between the cattle industry of the Gran Chaco region and of the other well known territories of Entre Rios and Patagonia. The location of the area, its natural conditions and the time and manner of development have created their own characteristics in the organization of the industry. Throughout Central Argentina and Uruguay the prevailing vegetation is grass. There are many varieties of grass. The damp, low-lying areas are covered by water and swamp vegetation besides these grasses, one of the characteristics of the area is the widespread occurrence of wax palms *(copernica australis)* which usually grow above a dense carpet of grass. There are also *Lapacho* and numerous *Algarrobo*. These are mostly found on the edges of the high forest and in isolated clumps in the grasslands. Numerous shrubs, especially *tala* and *Mistol*, are of great importance as a basic source of fodder for the cattle. Some of the forest land cleared

and converted into *potros*. The huge estate is divided by wire fences into *potros*. The remaining areas were gradually taken into more intensive use for cattle farming.

Animal husbandry in Argentina is practised almost exclusively on the basis of natural pasture. The breeding of new varieties of fodder plants more suited to the climatic conditions is still in its mature stages. The natural conditions for cattle grazing deteriorate steadily from east to west. Due to climatic zoning, fodder supplies become increasingly sparse and natural sources of drinking water for cattle decrease steadily from 200 kms. west of the river Panama and far enough west ultimately cease to exist. Intensification of the cattle industry in Argentina, especially in respect of meat production, depends on how far natural disadvantages can be overcome. Especially important is the creation of permanent artificial pastures and the breeding of high quality, disease resistant crossbred cattle. Developments of this kind are already in hand.

Argentina and Uruguay produce, milk, butter, cheese and cream for local consumption, but dairying is relatively unimportant in comparison with the meat industry.

In the south eastern portion of Australia, especially in New South Wales, Victoria and parts of South East Queensland. Cattle rearing on higher grounds is more important. Grazing supplemented with other enterprises—this dairy belt is more homogeneous in its livestock characteristic. In the south eastern portion of this belt, in the foothills bordering the Victoria and New South Wales and Riverina, cattle rearing on low lying grounds is more important. Grazing in Queensland is very similar to grazing in Victoria, Australia is more noted for ranching than for dairying because much of the country suffers from unreliable rainfall, and 70% of the continent receives less than 500 m.m. rain per year. Commercial livestock farming is thus restricted to the more humid south-eastern portions of the continent.

New Zealand, like Australia is a major livestock country with more than 2 million livestock, but owing to the smallness of its population more than half of the milk produced is processed into butter or cheese for export. The climate is very similar to that of Mediterranean region, but more sunny. Westerly winds prevail at all seasons, and bring a heavy fall to the western seaboard, where it is promoted by the Southern Alps. These mountains are therefore well forested, and the luxuriant vegetation includes magnificent tree-ferns. The drier Canterbury plains form excellent pasture-lands devoted to sheep and cattle rearing, and are also well suited for growing wheat and barley. The main livestock regions are on the wetter west of the North Island : the Auckland Peninsula, the Taranaki Lowlands, the Waikato-Hauraki district and the scattered areas of the eastern lowlands. The growing proportion of wool and milk products in the total value of the country's agricultural

production and exports and in particular the present development in the use of land all reflect the increasing importance of cattle raising in New Zealand.

NOMADIC HERDING

Nomadic herding is an extensive form of animal grazing on natural pasturage, involving constant or seasonal migration of the nomads and their flocks.

Widescale nomadic herding is practised in many parts of Africa, especially by the Fulani of the West African Savannas, by many different peoples, including the Masai, in East Africa and the Nuba in Ethiopia and Sudan, and by the Bantu and Hottentots of Southern Africa in Botswana, Mozambique and South Africa.

The *Vlahs* or *Aromiani* of Southern Europe and nomadic tribes of Himalaya also practise nomadic herding in Alpine regions. The livestock are hered by various members of the family. Cattle and horses are kept fairly close to the settlement and are generally looked after by the children and old people, sheep are taken some distance in search of pasture and water. The shepherds are generally men and boys, but young women often go rather far from the settlement with the flocks. The shepherds know the mountain pastures well and the best times of the summer for their use.

The herding techniques are mostly primitive. The dogs are used solely to protect the sheep from wolves, which are common in the area. The shepherds keep the flocks in motion by shouting and change direction or control strays by throwing stones or by their sticks. Once the pastures have been reduced, the tempo of life slows, and one finds groups of children playing or sitting, each with his homespun bag containing loaf of breds and a bottle of water, or a young woman spinning wool with a distaff and spindle, while the sheep graze nearby. Although the idyllic aspects of the pastoral life have been exaggerated, one cannot but agree with the words of Djilas, himself born and bred in the mountains of Montenego, "Life on the mountains is not easier or more comfortable, but it is loftier in everything. These are no barriers between man and the sky. Only the birds and clouds soar by......on the mountain there is something for everyone—for the young, brightness and play, for their elders, sternness, and constraint. Sorrows are more sorrowful there, and joys more joyous, thoughts are deeper, and follies more innocent."

The herds and their livestock leaves higher hill about October, when temperatures on the higher pastures are beginning to fall. The stock return to the upper grasses, and during the autumn and winter they are moved in stages lower down valleys and the lower grasses, which they reach at the end of November. At the beginning of February the cycle begins again.

There has been considerable discussion in geographical literature about the terms applied to livestock movements of types

discussed above. The term nomadism has been used by many geographers to describe annual movements of whole families with their livestock. In other word's, nomadism is the movement of family groups or tribes with the livestock between summer and winter pastures. The people have no fixed settlements and no permanent agriculture, they make no provision for winter stalling or fodder for their livestock. Within the areas of their summer and winter pastures they tend to move around. The fact that the winter pastures do not lie in the immediate neighourhood of the fixed settlements adds an element of oscillating or double transhumance.

Carrier states that "the nomadism is now limited to the shepherds, but less than sixty years ago it included a much more extensive system of migration," with the whole population on the move, since the people possessed no permanent dwellings and engaged in no agriculture. This nomadism could not be considered absolute because the direction of the wanderings was governed by the season and the traditional right of use. Carrier, writing in 1932, thus suggests that annual movements by family groups ceased in the every corner of the world day by day.

The term transhumance has been used to describe movements in which only herds take part, leaving their families in the permanent settlement. A further refinement to the definition of transhumance is the idea that movement must take place between two regions of different climate. This seasonal migration from winter to summer camps for the benefit of livestock among the people in semi-arid or mountainous areas, was formerly widespread in all over the world and is generally referred to as transhumance. This type of activities are mostly confined in Alps and Himalayan ranges. In these regions the periodic movements of people with their livestock or herds between summer and winter pastures are most prevailent. In the spring, with livestock, of family groups or herds they are taken into the mountains, often at first to an intermediate pasture where grass growth or hay making also takes place, and later, when the snows have melted to the high mountain pastures. The distance between the pastures and the permanent settlement in the valley are usually short, and cattle rather than sheep are the commonest livestock. In general, only a few family members or hired herds take part in the movements. Transhumance has become so much a part of the life of the some people or tribal peasant that the practice has been maintained for many generations, in times of peace and of war.

Two kinds of area predominate—one is in the far north of the Eurasian land mass, extending a short distance into northern Alaska and Canada. This is the land of the reindeer herders like Lapps and Eskimos—who graze their animals on Tundra vegetation. Practically no crop is grown there. The second region extends through the arid, semi-arid and Alpine portions of Europe, Asia and

Africa, where varied types of generally low quality animals such as horses, sheep, goats and camels—feed on sparse grasses. With few exceptions this type of economy thus contributes practically nothing to national economies.

Map 25·3 shows the agricultural regions of the world, generally in very simplified form. In order to present a more complete picture, the individual regions is previously described in very short. The map shows quite well the general sequence from equator to poles. Different crops are predominant in different proposed agricultural regions of the world. Rice and Jute are raised mainly in South Eastern Asian countries. Wheat and sugarbeet in the temperate zone. Cotton in black-chernozem regions of the world. Diversity of products of the world is the outstanding characteristic of agriculture. The, use of land, like the climate, is marked by transition. It changes from the rice, tea and sugarcane of tropical region, still prevailing in the temperate to the wheat and sugarbeet economy of the U.S.S.R. and U.S.A. According to such statements it might be concluded that no general principles of agricultural regions can be propounded, and that every land use plan requires an *adhoc* classification.

CHAPTER 26

GEOGRAPHY OF NUTRITION

'Whatsoever creatures are contained by the earth, truly, all of them are born from food ; likewise by food and food alone they remain aiive; moreover they return into it in the end. Surely food is the first and pre-eminent among all that is created; hence it is regarded as the medicament of all. For food is the first among beings, hence it is called a panacea. Living beings are born from food; having been born they are reared by food; food is called 'annam' because creatures both consume it and are consumed by it."[1]

Fundamental Physiological Needs

Food is man's first biological necessity. Directly or indirectly he gets it all from plants or through the animals and fish whose food supply traces back to plants, often in its microscopic forms. Food being the elemental want of man, there is no more fundamental control of growth of population than food supply. Man's chief occupation wherever he is found is to acquire food for himself and his family.

The three fundamental requirements of human beings are food, shelter and clothing and might be called as "the fundamental physiological needs" by Brunhes, or the "material needs", according to Huntington. The geography of nutrition, according to Brunhes[2], "is linked up not only with the general geography of life but with the special geography of plant life.........so a human beings meals represent, directly or indirectly, the harvest, as it were, of a more or less limited area of the plant covering of the earth, either wild or cultivated."

Human beings and all others obtain the bodily energy and nutrients for their growth, development and sustenance by eating plants and animals. At twice or occasionally thrice a day he has to renew his bodily strength and energy by eating and drinking. As you know, the human engine needs energy, which it produces from food. If food is scarce or lacking the human engine runs down and in the end, it stops working altogether.

The body not only needs energy but also certain substances to ensure its balance, and, for this, animal products are absolutely essential. The body can not function properly on one food alone.

1. Translated from Taittiriyopanishad; Chapter 2, Lesson 2.
2. Brunhes, Human Geography, p. 31, 1952.

Yet there are parts of Asia where millions and millions of people have nothing to eat all their lives but a meagre bowl of rice, day after day and year after year.

Without the materials for body building and repair, the organism gradually grows weaker and one's health breaks down. Hunger leads to epidemics and infectious diseases which can decimate whole populations.

Functions of Food

One of the important functions of food is to provide calories. The calorie requirement depends on the type of occupation, body-build, climate, sex, age and several other considerations. In India, the requirements for men have been placed at 2400–3900 calories per adult per day and for women at 1900–3000 calories per adult per day.

Healthy and active citizens are a great asset to a nation. Nutrition plays a vital role in first five years in a child's life. Inadequate diet at this age may hinder their growth and mental development. Minerals and vitamins being protective against sicknesses, are essential for children, men and women. Children are often whimsical, what they like today, they may not like tomorrow. It is therefore, essential that their food has enough variety in colour, texture, flavour and cooking.

Diet of adolescents needs equal care. Inadequate diet at this age may affect the normal functioning of the body. Calorie requirements go very high at adolescent age and the diet should be rich in fats and sugars. Both these nutrients are concentrated sources of energy. Adolescent girls need more iron than boys. Their diet should include more of green and leafy vegetables. Liver is also a good source of iron.

Calories requirements of adults vary according to the nature of work, sex and climate. More the physical activity, more the caloties required. In old age the requirements go down. Therefore, wherever, he lives, man and his family must find some food. The quality and quantity of food is of fundamental importance in maintaining health is inescapable.

Contemporary Problems

Paradoxically, the principal nutrition problem of the industrialized countries today is one of over eating, with a consequent increase in obesity, cardiovascular disease, diabetes, and hypertansion.

In contrast, nutritional difficulties in developing countries are similar to those experienced in the industrialized countries 50 to 100 years ago. Children under five years of age and, to a lesser extent, pregnant and nursing mothers are most affected.

Common Deficiencies : The most common severe nutritional

deficiencies are those of protein and vitamin A. Protein—calorie malnutrition is widely prevalent among the poor segments of the population throughout the world. This form of malnutrition is more prevalent in the Monsoon and Developing countries, than in the developed countries.

Kwashiorkor is characterised by failure to grow, irritability and mental apathy, oedema, muscular wasting and damaged liver. Since there is a great need for both protein and energy to meet the demands for rapid growth, dietary restriction of either protein or calories or both, as is most often the case, will result in the development of kwashiorkor. Infections and infestations have a precipitating role. Studies recently conducted in India and elsewhere have indicated that children who have once suffered from severe protein-calorie malnutrition in their early childhood may suffer from permanent physical stunting.

Inadequacy of food supplies, poverty of the masses, their ignorance and food prejudices make the problem of prevention one of real difficulty. Proper use of available resources is an important step in combating this deficiency. Successful treatment of kwashiorkor with diets based upon vegetable proteins especially legumes, indicate that educating the mothers in appropriate infant and child feeding practises making use of these locally available cheap vegetable foods will go a long way in controlling this problem.

The best indicator of the prevalence of Kwashiorkor due to protein deficiency is the mortality rate for children one to five years of age, which is commonly 20 to 50 times higher in developing countries than in areas like Western Europe, the United States, Australia, New Zealand, and Japan.

Vitamin A deficiency is also most common among school children, it causes severe eye lesions which often result in blindness. In Indonesia and other countries of South East Asia, deaths from secondary infection are particularly common in children with Vitamin A deficiency. This deficiency could be readily prevented by the green and yellow vegetables that are, or could be, widely available in most countries.

Nutritional diseases may arise from either inadequancy of an essential food element such as protein or due to the presence of an undesirable compound. So the problem for nutritionists is essentially either to see that a desirable nutrient goes into the dietary in required amounts; or to ensure that the undesirable elements are removed. This has to be achieved without a sudden change in people's dietary habits.

Our dietaries are notoriously poor in protein. Not only the quantity but the quality of protein is low in our average foodstuff. This deficiency is a source of great danger to health, both physical and mental, particularly of growing children. Geneticists have evolved some new cereals with higher protein content. Hybridisation

can also increase the lysine (a growth promoting substance) content of some foodstuffs.

Every year, thousands of farm labourers in M. P. and Maharashtra are crippled by lathyrism, an incurable paralysis of the legs caused by excessive eating of *kesari dal* (Lathyrus sativus). The pulse is hardy and is very low-priced and, therefore, is a staple of these victims. For centuries, the disease has continued to take its heavy toll because the people could not be stopped from eating *Kesari dal*.

Lathyrus is hardly enough to survive even under severe drought conditions. The crop yields are good and the labour required to grow it is minimum. Under these circumstances, it has not been possible for the Government to ban the cultivation and sale of this *dal*. In fact, many agricultural labourers are paid their day's wages in the form of this toxic dal. The disease afflicts more men than women. Kesari dal has a poisonous ingredient constituting about 1 percent in the dry seeds. Fortunately the poison is not of the cumulative type like lead or D. D. T. The dal is banned in Delhi but because it is very cheap, has found its way into various types of pulses. The whole *dal* is used to adulterate whole masoor, channa, urd etc., while the skinned dal is mixed into the various yellow dals.

The high incidence of stomach cancer in the Japanese, according to some reports, seems to be due to the consumption of rice polished with asbestos-contaminated talc. Thorough washing of the rice does remove some of the talc but it was found that no amount of rinsing could dislodge the talc completely. Consumers should reject all artificially coloured and polished rices or pulses, because both the colouring material and the talc used on them can produce cancer. Asbestos, which may be present in the talc, can cause gastro-intestinal cancer.

A large segment of labourers in the Deccan Plateau have *Jowar* as their staple. Pellagra has long been known as a classical nutritional deficiency disease affecting poor population groups subsisting on maize diets. The disease is rare in areas where rice or wheat is the staple. On the other hand, pellagra is common in the Deccan Plateau of India, "where it accounts for nearly 1% of all general hospital admissions and nearly 8 to 10 percent of admitions to mental hospitals in Hyderabad."[1] A careful examination of the poor segments in this region, however, the report shows that the stable is not maize but the millet Jowar (Sorghum Vulgare). Both Jowar and maize have however one common feature with regard to their amino acid composition: a high content of Leucine. The disease is characterised by skin disorders (dermatitis), mental derangement (dementia) and gastro-intestinal disturbances.

1. Nutrition Research Lab. Reports, 1970, Hyderabad.

Endemic goitre is due to deficiency of iodine and is widely prevalent all along the Sub-Himalayan belt.

INFLUENCE OF ECOLOGY ON FOOD

Wherever man lives he has to adapt himself to his surroundings in order to get the two fundamental necessities of food and shelter. The need for clothing, which is a form of shelter, is decided by the climate.

Man is a creation of his environments. A group of people can only prosper, increase, and grow powerful, when their environment supplies them abundance of food and other necessary things of life. Food supply, according to Stamp "is one of the closest ties between man and his environment."[1] Every man, whether he may be rich or poor, civilized or uncivilized, resident of cold climate, or living in warm latitudes, requires food, clothes, house, fuel, luxuries, tools and materials of industry which enable him to produce and handle the others.

All the above mentioned things are produced directly or indirectly from Nature. Nature determines to a very great extent the occupation of the people, their dress, their mode of living, and their habits. According to Blache[2] "Societies have always begun to seek ways of satisfying their needs in the immediate vicinity."

Early man's discovery of tools, of fire for cooking his foods, and, of inter-communication through speech gave him great advantage over the rest. He increased his security against competitors and beightened his capacity for securing his food, shelter and safety. A major revolution came when he tamed wild animals for his use. The dogs, the wild ass, camel and cattle came under his control This meant help in the chase and insurance against failure to secure food. In fact it was the precurson of tinned food. He increased his herds and penned them for protection against predators. These cattle in confined areas, consumed more grass than the soil could produce and plant life died. The exposed soil was beaten into a thick crust by the main drops and stopped absorbing more moisture for the root zones. The surface water flowed away carrying nutritious soil. This was the beginning of man-made deserts. The owner of the cattle moved on to fresh pastures leaving deserts behind.

Food, according to Semple[4] "is the urgent and recurrent need of individuals and of Society. In dictates their activities in relation to their land at every stage of economic development, fixes the locality of the encampment or village, and determines the size of the territory from which sustenance is drawn. The length of residence in one place depends upon whether the springs of its food supply are perennial or intermittent, while the abundance of their

1. L. D. Stamp—Our Developing World, p. 70, 1960.
2. Blachc, op. cit , p.320.
3. Semple, op. cit,. pp. 61-61.

flow determines how large a population a given piece of land can support." Agriculture transformed the life of man. The variety of foodstuffs on which man can subsist is so great, and their distribution is so extremely complicated, that we shall later devote some chapters to considering them in more detail.

The over-all volume of food production in various parts of the world is determined by the abundance or scarcity of arable land in relation to population, fertility of the soil, climatic conditions and the level of agricultural development and techniques. The increased demand for plant produces has several aspects. With security from competition with other animals and increased consumption and better health standards, the population has grown greatly. In the state of nature there is a high birth and high death rate and little net increase. With more security the death rate decreases. Only at a very advanced stage of material and intellectual level does a voluntary lowering of the birth-rate come. At its present rate the population of the world as a whole is inclined to double itself each half-century. While there seems no limit to this process, there is clearly a limit to the land available for production of human food in vegetable or animal form. "The inter relations between man, his food, the animals and plants which produce the food and eat it or each other, and the physical environment which ultimately decides what kind and quantity of food will be available, are extraordinarily intricate and fascinating."[1] Technologically man has tripled and quadrupled the produce per hectare in agriculture in the last century in Europe But whether this rate can be maintained and whether it can cope with the rate of increase of population is a matter on which there is difference of opinion and at best is a guess. Some hold that ultimately we shall have to get our foods from algae, the greenish organism which gathers on undisturbed water surface.

Man is thus, like the animal, dependent for its food, continue to live on green plants. It is the plants that make the foods, the animals eat them. Plants are the starting point in this food-chain. A food chain starts with the green plants, which are known as the producers. Man plays many roles in food chains, but his most common one is that of a herbivore, since grains and other plant materials make up a very great proportion of the diet of most human beings. In nearly all food chains the animals that form the lower links in the chain are not only smaller but also more numerous than the animals that prey on them. The smaller an animal is, as a rule, the more rapidly it increases in numbers, it leads a shorter life, matures more quickly and produces more young than a larger animal. When man consumes fishes, he often occupies positions even further along the food chain, because many fishes are tertiary or even quaternary consumers themselves.

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1. M. S Anderson, Geography of living Things, p. 72.

According to Anderson[1], "the kind of food we eat is probably far more a matter of habit and tradition than of deliberate choice of physiologically suitable diets". Food is the burning question in society, and the whole structure and activities of the community are dependent upon question of food-supply. Hunting peoples, therefore, are generally few in numbers, and spread over great stretches of country. Hunter and Fisher, relying almost exclusively upon what their land produces of itself, need a large area and derive from it only an irregular food supply, which in winter diminishes to the verge of famine. Local famines are a symptom of poor adjustment of man's numbers and way of life to his local environment.

The hunter of the cold icy wasters is the Eskimo. Here the ground is covered with ice or snow most of the year, and permanently frozen below the surface. Plant and animal life are reduced to a minimum on the land, so that man, with every poleward advance of his thin-strung settlements, is forced more and more to rely on the sea for his food. Hence he places his villages on narrow strips of coast as do the Norse of Finmarken, the Eskimo and the Tunguse inhabiting the Arctic rim of Asia. Products of marine animals make the basis of his domestic economy. Farther inland, which means farther south, all tribes live on hunting and fishing. Eskimo hunts in Canoes made of the whalebone or driftwood and covered with skins. His chief weapon is the harpoon made of driftwood and fitted with a sharp point of bone or stone. In summer, when the sea is open, the Eskimo goes out in a Canoe to hunt the Seal, but in winter, when the sea is frozen over, he lies by the side of the holes where the seals come up to breathe, and kills them with a spear.

The daily food of the Bedouin is meal cooked in sour camel's milk, to which bread and meat are added only when guests arrive. The camel provides its owner with milk to drink, hair for making ropes, cloth and rugs and sometimes flesh to eat.

The Bedouin Arabs who wander about in the desert live a very different kind of life. They have flocks and herds, and because there is little water and grass at any one place, and wheat there is soon used up, they are always moving from one spot to another. Their chief animal is the camel, which is called the Ship of the Desert.

The Bushmen, who inhabit the Kalahari desert, have thin wiry forms and are capable of great exertion and privations. According to Anderson,[2] "the Bushmen, skilled hunters who formerly ranged over most of Southern Africa, have been forced by the Bantu and later by the white men into the parched shadeless scrub lands of the Kalahari desert whither the game has retreated, and in that arid and uninviting land years of plentiful food are all too rare;......

1. Op. cit, p 85.
2. Op cit, p. 90.

the Bushman literally never knows where his next meal is coming from, nor whether it will come today, tomorrow or never". The effect of a scant and uncertain food supply is especially clear in savages and tribes, who have erected fewer buffers between themselves and the pressure of environment. This is true in particular or primitive peoples living in a very difficult environment, such as the margins of deserts, the Arctic regions, or the wet, sunless beech forests of the extreme South of Chile.

The daily food of the shepherd agriculturists on the 'Himalaya west' of Uttarakhand is bread and milk, meat is indulged in only three or four times a month. The flesh of goats or sheep or wild animals dying a natural death is used as food ; in summer it is sun-dried for winter use, because at that time the Bhotiyas live exclusively on female Yak's milk which is then abundant.

NUTRITION PATTERNS

Nutritions patterns in different parts of the world have developed around local food production, each people adjusting habits and tastes to domestically produced foodstuffs. In sheep-raising countries, such as Australia and New Zealand, the per captia consumption of mutton and lamb is many times greater than in the United States, while the per cupita consumption of pork in the U.S.A. is many times greater than in those countries. In sparsely populated cattle-raising countries such as Argentina and Uruguay, meat consumption is among the highest in the world, while milk and dairy products predominate in Denmark, the Netherlands, Belgium, Luxembourg and the Scandinavain countries.

Primitive man in a favourable environment in which a variety of foods existed in unrestricted quantities had no serious problems relating to diet, he could rely solely upon his appetite as a guide to nutritive well being. When, however, the population increased to the point where migration became necessary, certain factors were introduced which exerted a direct influence upon the natural food resources hitherto serving as the major determinant of the diet of the people.

The factors of climate, ecology and population have exerted an important influence upon human food habits. In modern times economic factors have played an important part in bringing about a change in the character of diet.

In regions where agriculture is concentrated on production of grains, cereals constitute the bulk of the diet. Almost half of the food energy of a nation is obtained from cereals. The most important cereals are wheat and rice, used chiefly for food.

Rice is the staple food of the Asian peoples, almost half of mankind. In spite of the large hectarage under rice in Monsoon Asia, most of the countries of the South-East Asia are deficient in rice. While, Burma, Bangla Desh, Indo-China and Thailand have an exportable surplus, while China, Indonesia, India, Pakistan

and Taiwan are self sufficient in their rice requirements to some extent, the rest of the countries are deficient, and have to import rice to feed their people. Rice is the most important food crop of Monsoon Asia. Indeed, Asia could not support its teeming millions with any other crop. Inthe history of Asia failure of the rice crop time and again has resulted in famine and starvation.

Rice is the most important single article of food in the densily populated countries of Asia. In many parts of the country, 90% of the production is consumed in various cooked preparations, the great bulk as plain boiled rice. Rice is utilized for various cooked preparations, for industrial and non-edible uses or for the preparation of parched products.

In contrast to rice, wheat is raised in all parts of the world, occupying a larger part of arable land than any other crop. The largest producers of wheat in the world are Soviet Russia, U.S.A., Canada, Argentina and India. The traditional diet of these countries are based on wheat. In most of the European countries very intensive areas are devoted to root crops, such as potatoes, which are eaten by the peasants themselves. In most of the western countries the diet based on this farming is "our traditional English diet of bread, beef and bear : bread from wheat grown on the best land ; beet—with other meats such as mutton, lamb and pork—raised on grass and roots ; beer brewed from the barley in the standard rotation......The latest almost universal additions to our staple diet seem to be that curious synthetic product euphemistically known as ice-cream, sweets, and fish and chips."[1]

Corn or Maize, is the third great cereal crop and mostly grown in U.S.A., U.S.S.R., Argentina, Mexico, Rumania, Yugoslavia and Africa. Most of the corn produced on farms of the U.S.A. leaves them on the hoof.

Oats in the form of porridge ranks high among breakfast cereals in many countries of Europe, mostly in the north, and in the U.S.A. Rye, Sorghum and millet have more or less maintained their position in agriculture of the world, especially in Europe and the U.S S.R. Sugar, an essential energy food, is provided by the sugarbeet and sugarcane. The position of sugar in the world's agriculture changed several times during the 19th century, but after the first world war sugarcane dominated the field.

Meat is important in human diet because it contains protein of highest quality, many mineral elements such as iron, copper, phosphorus and others, some of the vitamins and fats. In most parts of the world cattle are valued for food and milk ; in India their primary purpose is draught for the plough and for the cart.

Fish is a very important food material in the diet of the man. Before agriculture was known, fishing was an important occupation of the human being. Even in the twentieth century the fish being

1 Anderson, op. cit., pp. 107—108.

a very valuable food material is in great demand. Countries situated near the sea, are carrying on a profitable business of exporting fish to other countries of the world. Thousands of men are engaged in this industry on the eastern coast line of the United States of America, in the North Sea and in the Japan Sea.

Because fish is cheaper than meat, its consumption within a country is usually large in low-income groups than among the rich. The development of fisheries in certain areas has been determined by geographic, economic and historical conditions.

There is a large consumption of fish in Bengal, Bihar, Orissa and Bangla Desh. It will be no exaggeration to say that nearly 90% of the population in these states taken them daily. In these parts the staple food of the population is rice which has more of starch, and therefore fish only supplies protied element in the diet. The sea is also the source of the fish supply in Kerala and western coast. The Kerala fishermen take their boats to the sea and remain there for weeks together engaged in fishing.

Tropical peasants who live primarily on starchy foods such as rice, bananas or potatoes get their energy requirements almost entirely from carbohydrates, but living in warmer climates and leading less active lives than the Eskimo or the Canadian boatman they need fewer total calories. Fig 26·1 shows the general dietary types of the world.

DAILY DIET

Good health results from a balanced diet that consists of right proportions of proteins, fats, carbohydrates, vitamins and minerals.

Proteins are needed to build and repair the body tissues, fats and carbohydrates to provide energy and vitamins and minerals to regulate body processes.

Proteins are of two kinds : animal protein and vegetable protein. Sources of animal proteins are meat fish, eggs, milk and milk products and of vegetable proteins the pulses (peas, beans, soyabeans etc.) and the whole grain (Oat meal, whole wheat meal, bread). Animal proteins contain more body building material than vegetable proteins. But when used with a little animal protein, the vegetable proteins are nearly as useful for body building as animal proteins.

Protein requirements of different segments of the population are not the same and are influenced by physiological conditions like growth, pregnancy and lactation. Protein requirement during pregnancy and lactation is increased due to additional protein needed for the growth of foetus and accessory organs in pregnancy and for milk secretion during lactation. Population groups who are chronically under nourished with poor protein stores may need extra protein over and above the minimal needs to replenish their body protein stores and withstand better the stress conditions like pregnancy and lactation. Protein intake to satisfy their minimal requirement would never provide them with a chance to build up their body proteins.

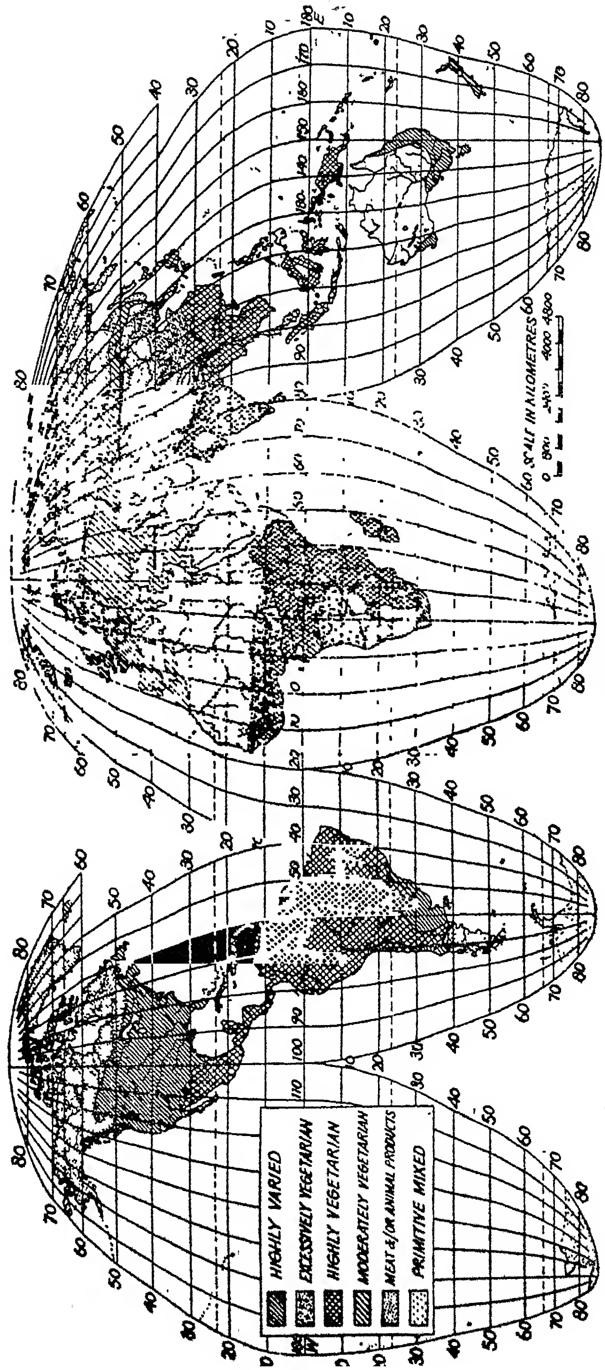

Fig. 26 1 Dietary Types.

Vegetables and fruits are outstanding sources of carotene, vitamin B and C and minerals like calcium and iron. Poor body stature of the most of the children is often attributed to low calcium intakes. There is widespread prevalence of iron deficiency anaemia in Indian population groups especially among women of child bearing age, in spite of a seemingly satisfactory dietary intake of iron. Significant loss of iron through sweat in tropical country like India and poor availability of dietary iron which is mainly derived from cereals and other plant foods may be responsible for this situation.

Carbohydrates and fats supply energy for every movement, from the beating of the heart to all the movements of the organism in daily work and recreation. They also supply heat. The foods rich in these nutrients are the fats (ghee, oil, butter, cream, etc.), the sugars (sugar, jaggery, honey, jams etc). flour, potatoes, oat-meal and other cereals. These nutrients should be taken only in a limited quality. If taken in quantities more than the body needs they cause obesity.

Energy Value

The energy value of food is measured in heat units called calories. The calories supplied by these three kinds of foods are shown in the table :

1OZ. of Fat supplies	275 Calories in air, 255 in the body.
1OZ. dry Cardohydrate supplies	120 Calories in air, 113 in the body.
1OZ. dry Protein supplies	120 Calories " " 113 " " "

According to the F. A. O. estimates, total daily calorie intake per person varies from country to country, ranging from less than 2000 calories in some developing areas, such as India, Peru, Philippines and others to more than 3000 in prosperous countries such as Canada, United States, Britain, Switzerland, Denmark and New Zealand.

According to various estimates, average daily food requirements in most countries of the temperate zone vary between 2600 and 2800 calories ; about 2840–2850 for Swedon and Norway ; 2710–2750 for Canada, Switzerland and Denmark ; 2600–2670 for the United States, Belgium-Luxembourg, the Netherlands, Great Britain, Argentina, Australia and New Zealand. In countries with a warmer climate the requirements are estimated at 2250–2500 calories for Pakistan and India, and 2440–2550 calories for Italy, France, Portugal, Turkey, Brazil, Mexico and Venezuela.

After having established minimum food requirements for different countries, the Food and Agriculture Organization of the United Nations estimated nutritional targets for respective countries for 1970. These targets represent a compromise between the net food supply available per person at retail level in 1960–65, the physiological requirements and the economic feasibilities. The

F.A.O. targets were below the actual intake in 1960–65 in some countries such as in Denmark, Great Britain, Australia and others. These data are shown in Table 26·1.

Table 26·1

Daily Food intake, Requirements and Targets in selected countries[1] (calories per capita of population)

Country	Intake 1960–65	Requirements	Target
Norway	3,136	2,850	3,190
Sweden	2,973	2,840	3,120
Denmark	3,298	2,750	3,120
Switzerland	3,099	2,720	3,120
Canada	3,032	2,710	3,050
New Zealand	3,289	2,670	3,180
Great Britain	3,231	2,650	3,120
Chile	2,488	2,640	2,600
United States	3,092	2,640	3,110
Finland	3,102	2,630	3,180
Netherlands	2,925	2,630	3,030
Australia	3,040	2,620	3,150
Benelux	2,928	2,620	2,8[illegible]0
Argentina	2,799	2,600	3,170
Uruguay	2,950	2,570	2,720
France	2,783	2,550	2,890
Colombia	2,280	2,540	2,590
Peru	2,077	2,490	2,340
Mexico	2,050	2,460	2,420
Cuba	2,740	2,450	2,820
Portugal	2,363	2,450	2,730
Brazil	2,342	2,440	2,470
Italy	2,594	2,440	2,680
Venezuela	2,275	2,440	2,490
Turkey	2,669	2,440	2,580
Nigeria	1,920	2,430	2,290
Tanganyika	1,980	2,420	2,230
Union of S. Africa	2,651	2,400	2,510
Greece	2,536	2,390	2,634
Egypt	2,390	2,360	2,390

1. Statistics from different sources. F.A.O. Publications and U.N. Statistical Year Books

Japan	2,165	2,330	2,210
Pakistan	2,025	2,300	2,230
Ceylon	1,970	2,270	2,200
India	1,837	2,250	2,000
Philippines	1,957	2,230	2,250

Apart from this general correlation between the level of prosperity, roughly measured by the per capita income and daily intake of calories, the pattern of nutrition in different countries depends on climate, composition of the population and national food habits. The unique position of Ireland with its daily 3483 calories per person is accounted for partly by the cool moist climate of the Island and partly by the large proportion of starchy foods (potatoes) in its diet. Similarly, Uruguay with its very high consumption of livestock products consumes daily nearly 3000 calories per person. The same is the case with Pakistan although it does not permit it to rank among the prosperous nations. The per capita consumption of calories are shown in Fig. 26·2.

Nutrient Requirements of Indians

One seventh of human race living in India under democratic pattern is determined to meet its food and fibre requirements and maintain a certain minimum of soil fertility balance. For producing 272 million tons of food required by 1981 the existing rate of increase of production has to be trebled. Estimates of food requirements from nutritional point of view have also been made. The estimates are based on minimum and medium levels of caloric requirements. Broadly, the minimum level covers the needs for animal proteins of infants and children below six years of age and partially of other Vulnerable groups. The medium level, in addition, covers more fully the needs for animal proteins of school going children of ages 6 to 19 and provides for more adequate allowance for other vulnerable groups. Protein is an important constituent of the diet and is necessary for growth and replacement of the tissue wear and tear. The all India average per capita consumption of protein has been estimated to be about 53 gms. per day. In view of the high consumption of cereals, the protein requirement appears to be met on an average. Table 26 2 shows the average intake of nutrients in the different states of India.

Table 26·2

Average intake of Nutrients in India.* (Per capita per day)

State	Protein (gm.)	Calories
Karnataka	65·2	2040
Andhra Pradesh	49·4	1820

* I. C. M. R. June, 1968, published annually. Report of Nutrition work done in states—1955 to 1966.

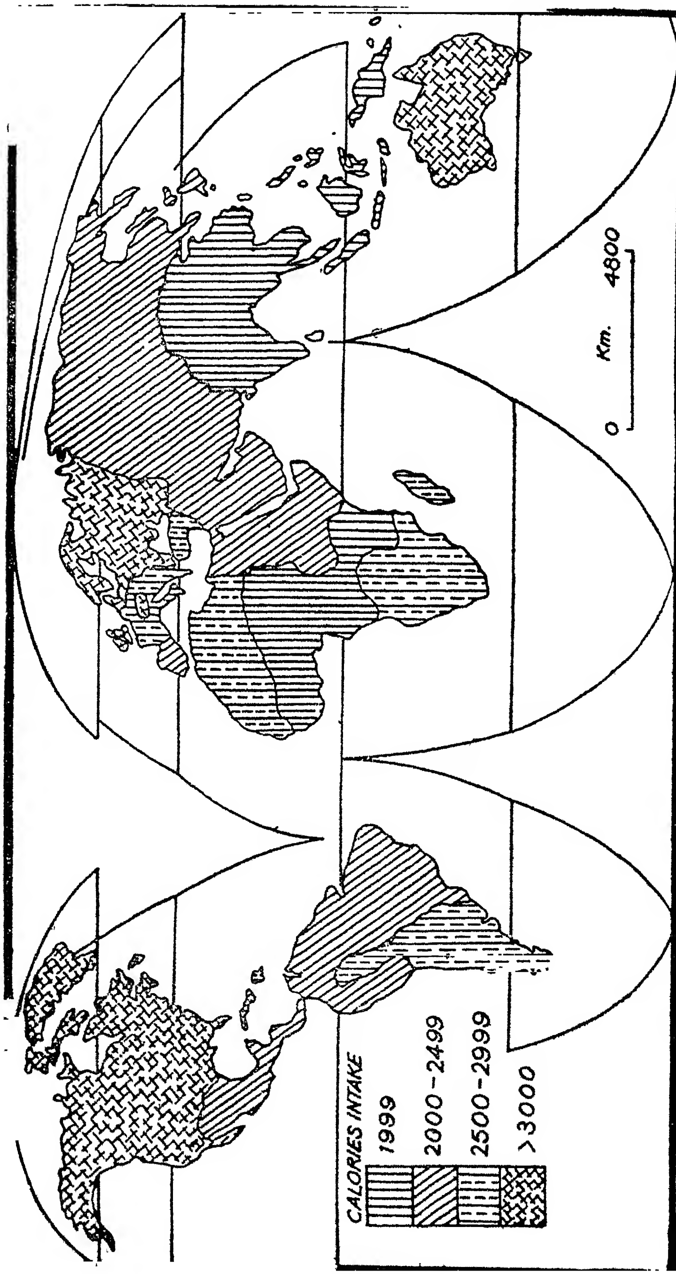

Fig. 26·2. Calories intake in different regions.

Bihar	54·9	1950
Gujarat	54·1	1430
J. & K.	65·4	2260
Himachal Pradesh	75·6	2460
Kerala	48·3	1670
Madhya Pradesh	93·3	3000
Tamil Nadu	38·7	1490
Maharashtra	48·4	1790
Rajasthan	70·2	2360
U. P.	66·3	2210
West Bengal	58·5	2100
All India	53·0	1890
Suggested allowances	44·0	2400

Protein-calorie malnutrition is a problem of great magnitude

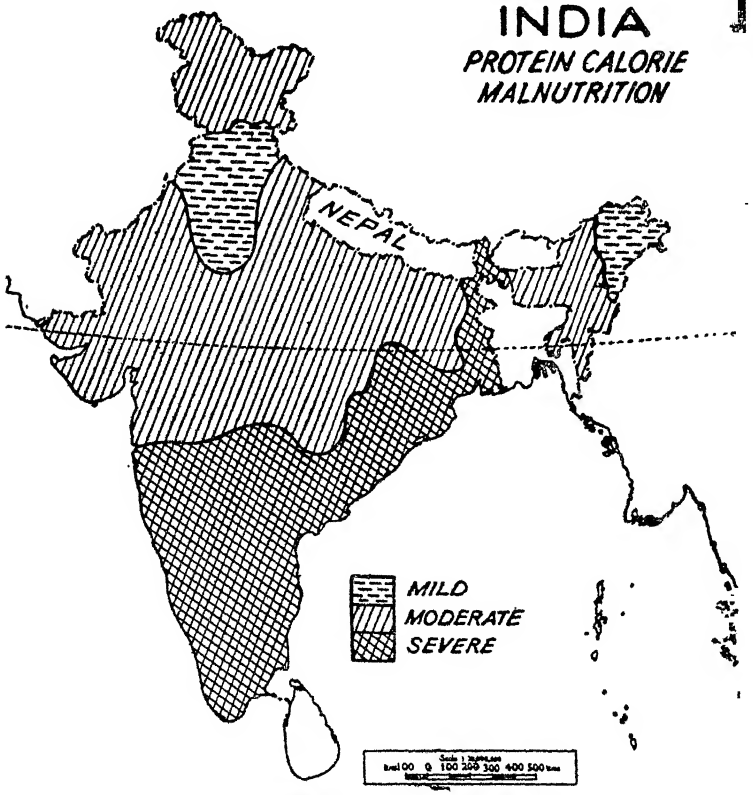

Fig. 26·3. Protein calorie malnutritio1.

and is wide spread almost throughout the country, though to different degrees in different regions. Available evidence indicates that severe degrees of Protein-calorie malnutrition are seen along the rice-eating belt of the country, *i. e.,* in South India, part of Maharashtra, Orissa, Karnataka and West Bengal. The geographic distribution of Protein calorie malnutrition in children is shown in Fig. 26·3.

Cereals such as rice and wheat or millets such as jowar and bajra occupy a predominant position in the Indian diet. Pulses also constitute an essential ingredient of our national diet. Tney provide substantial quantities of protein to a nation impoverished by protein malnutrition. The protein content of an average Indian diet is only 53 grams per day, as compared to 95 grams in an average American diet. Of this 53 grams, animal proteins constitute only 6 grams, the rest being derived from cereals and pulses. Cereals have a protein content of 8–12 percent, while pulses have much more about 20 percent. It is obvious from the above that the quality of pulses consumed should be the best possible.

The per capita intake of calories and proteins among adults is the highest in Madhya Pradesh and the lowest in Gujarat among the Indian States. The survey on food habits carried out by the Protein Food Association of India points out that while an adult in Tamil Nadu gets on an everage slightly over 2,100 calories (as against a requirement of 2600 calories) and 61·6 grams of protein (as against the recommended 55 grams) a day, a Keralite gets only 1670 calories and 48 3 grams of Protein.

The intake of calories among adults per day was 1880 in Andhra Pradesh and 2040 in Mysore while the consumption of proteins was 49 4 grams in Andhra Pradesh and 65·2 grams in Karnataka.

The consumption of calories by school children (6–15 yeas) per day was 1560 in Tamil Nadu, 1470 in Andhra Pradesh, 1424 in Karnataka and 1399 in Kerala. The consumption of protein by the same age group was 45 7 grams in Tamil Nadu, 44 grams in Karnataka, 43·1 grams in Andhra Pradesh and 40·4 grams in Kerala.

The average daily intake of calories by pre-school children below five years was 950 in Tamil Nadu, 939 in Andhra Pradesh, 884 in Kerala and 838 in Mysore. The consumption of proteins among this group was 27·7 grams in Tamil Nadu, 27·5 grams in Andhra Pradesh, 25·8 grams in Karnataka and 23 grams in Kerala.

The survey points out that the low protein consumption in Kerala was, however, partly compensated for by the consumption of fish, which is eaten almost every day by almost everyone.

Kerala is also unique in its cereal consumption pattern. Its total per capita consumption of cereals in the diet amount to only 274 grams, which is far below that of the other states. This is, however, compensated for with tapioca (165 grams).

Tamil Nadu and West Bengal are almost totally rice-eating this cereal forming 400 grams out of the average daily cereal total of 439 grams. Mysore, Maharashtra, M. P. and U. P. have the greatest diversity of cereals, consuming rice, wheat, *jowar*, *bajra*, *ragi* and pulses.

The northern states of India have the highest per capita consumption of pulses (60 grams) and in Southern States the consumption of pulses is recorded lowest in Kerala (21 grams) state.

In contrast to the cereal consumption pattern, the pulse consumption was higher in the urban areas than in the rural areas.

The per capita consumption of all animal food in United Panjab is 150 grams which is seven to ten times that of the other states. The consumption in Andhra Pradesh is 15 grams, Mysore 17 grams and Tamil Nadu 11 grams.

After Bengal, Kerala leads in the per capita consumption of oils and fats, mainly coconut oil (21 grams) and is followed by Andhra Pradesh (14 grams) and Karnataka Gujarat and Tamil Nadu (10 grams each).

The consumption of milk and milk products ranged between 10 and 300 grams a day in all the India states. It was the highest in Haryana (300 grams) and the lowest in J. and K. but all are far below the recommended quality of 200 grams.

Jammu and Kashmir has by far the highest daily consumption of both green leafy vegetables (160 grams) and other vegetables (60 grams).

The survey of Protein Food Association of India shows that as a result of low income, children aged between 6 and 15 years were the great suffers nutritionally while adults were comparatively less affected.

Nutrient Requirements of Indians for Different Activities

One of the important fields of research in nutrition is the determination of human requirements of different nutrients. As compared to the work on nutrient requirement that has been done in the west, experimental studies which have a bearing on the nutritional requirements of Indians are by no means extensive. Ramanamurthy and Patwardhan[1] have determined the energy cost of different day to day activities, such as sitting, standing, laboratory work etc., in Indian subjects belonging to the middle income group engaged in light or moderate work. Ramanamurthy and Dakshayani studied the energy expenditure of poor class people engaged in heavy manual labour, like stone cutting. Ramanamurthy and Belavady studied the energy expenditure and

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1 Ramanamurthy, P. S. V. & Patwardhan, V N.—Annual Reports of the Nutrition Research Lab, 1956–1960.

calorie requirement of agricultural labourers in eight volunters during different agricultural activities.

An idea about daily allowances of calories for average Indians as recommended by the Nutrition Expert Group is shown in the following table 26 3.

Table 26·3

Recommended calorie allowance for Indians[1]

Particulars	Net calories per day
Man	
Sedentary work	2,400
Moderate work	2,800
Heavy work	3,900
Woman	
Sedentary work	1,900
Moderate work	2,200
Heavy work	3,00
Pregnancy (second half of pregnancy)	+ 300
Lactation (upto 1 year)	+ 700
Children	
1–3 years	1,200
4–6 years	1,500
7–9 years	1,800
10–12 years	2,100
Adolescents	
13–15 years boys	2,500
13–15 years girls	2,200
16–18 years boys	3,000
16–18 years girls	2,200

A number of tribal groups exist in different parts of India. In general, rice and millets form the staple food of most tribes except in the case of Mompas of NEFA who take a little wheat in addition. The diet of the tribes is very simple. It consists of a boiled cereal and some boiled green leaves or fish or meat.

For the first time, the Indian Anthropological department has undertaken extensive systematic investigations on the dietaries,

4. Patwardhan, V.N —The Proc of the Ninth Pacific Sci. Cong. vol 15, pp 103–107. Dietary allowances for Indians : Calories and Protein's. I.C M R Special Report Ser. No. 35, 1–20.

nutrition and adequacy of foods, the general causes of various ailments, the birth and death rates, the expectation of life, the rate of growth among children, basal metabolism, etc., among the primitive tribes of India. The aim of these studies is to evaluate the effect of the dietary habits on the constitution of the aboriginal tribes,

Generally animals such as deer, wild boar, squirrels and wild animals are hunted for food, and birds and field rats are caught in traps. Where there is a river nearby, the fish are caught by laying traps and poisoning the water. Chickens are quite frequently taken by the Indian tribes but on spceial occasions pigs are slaughtered. Many advanced well-to-do families of tribes own a semi-or domesticated animals such as sheep or goats or mithan. These domestic animals are sacrificed on social and religious occasions for the supply of meat and finds a ready market and is often bartered for cereal grains or other vegetables. Alcoholic beverages such *Apong* or *Jand* or *Kadon* or *Laida*, etc. form a significant proportion of the diet of the tribes.

GLOBAL MALNUTRITION PROBLEMS

The food and nutrition problem in the various countries and thus also the protein problem should not be regarded in isolation, but always in conjunction which the task of the total economic development and social modernization of these countries "The actual chain of cause and effect runs : unemployment poverty-lacking effective demand-limited production of food–under nutrition."* Yet it is becoming increasing clear that it will not be sufficient in the regions threatend by under nourishment and malnutrition to work in general towards economic development with the view that given a greater economic growth, the problems of food supply and nutrition will more ro less automatically be solved. Rather, one must urge for such instances that the quantitatively and qualitatively sufficient supply of food be guaranteed as one of the major goals for developmental work.

Even where such a notion has been accepted in principle, the desirable coordination between the development planners and agricultural experts as opposed to nutritional exports will all too often be lacking. There are hardly any national nutrition strategies which are not merely aimed at preventing hunger in general, but also at a comprehensive solution of a specific problem, e g. protein deficiency.

The total protein requirement of a human being is determined by body weight, age, activity, climate and special physiological requirements It is at its maximum during periods of rapid growth, i e., in fants, in children and in adolescents ; it is also particularly high in pregnant and nursing women In addition, the entire requirement is also determined by the protein valence : the fewer essential

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* O. Matzke, The Problem of World Hunger as a Question of General Development, New Zuricher Zeitung, March 1970.

amino acids are represented in the average diet, the higher will be the total protien requirement in order to cover the physiological minimum. FAO gives a total of 61 g. of protein per caipta and per day as the mean requirement for the developing countries.

What reasons may be given for a varying supply of protein ?

The structure of food production of the different countries is the primary importance, which for its part is in turn based on ecological conditions, on the level of technology and economic development, not to speak of the national pattern of food prefrences. The more tubers, rice or maize are favoured as the main source of food in a given country, and the less agriculture is based on animal production, the greater on the whole will be the total deficit and this especially for the essential amino acids.

Second important factor is income situation. If, for example, the protein supply for the developing countries is compared with that for western Europe or North America, a sharp difference will be seen in the quality of total disposable protein and especially in the portion of animal protein. It is a known fact that with increasing income the effective demand for protein and especially for animal protein increases, while the income elasticity of demand is reduced with a high income.

A third important factor for a deficient supply is found in the structure of food preferences and in feeding habits. There apparently tend to work in the direction of intensifying mal-nutrition rather than under nutrition. Thus, for example, in many countries consumers will cling to such plants as casseva as their chief source of food, which has less than 1% protein content, although other crops combining calorie content with an improved protein content can just as easily be cultivated, One can frequently observe how men are given greater quantities of meat or fish at the main meal than women and children. Often milk will be completely lacking in the diet of only recently weaned infants. Such habits are often deeply anchored in the culture. Changes become especially difficult if they have to do with avoidance rules (food taboos) that are clearly based on religion.

A fourth factor is also great importance, viz. insufficient knowledge about physiological conditions, that is to say about the body's physiological requirements for food and the nutritional value of various food products. This knowledge even in the industrial countries with their high standards of education is often not satisfactory and all that much less in the developing countries, with their educational systems scarcely even touched by the natural sciences.

Upto now mainly individual scientific institutes in developing and industrial countries, international organizations, particularly various agencies of the United Nations, or private enterprises interested in non-conventional protein rich products have occupied

themselves with the protein problem. Over the past five decades, the FAO and U.N.A. World Health Organization have collected valuable data on the nutritional quality of the diets prevalent in the various regions of the world and among different segments of the population such as pre-school children pregnant and nursing women, tribal groups and others. The problem of malnutrition of the world is of special concern among pregnant and nursing women and children. Eight hundred million children in the world are under-fed. School gardens enable them to learn how to grow fruit and vegetables that can provide a source of good food for them.

In many regions where children are badly fed at home, school, feeding programmes help to make up vitamin and other nutritional deficiencies.

Every year, diseases are responsible for the death of hundreds of thousands of head of cattle, causing hardship to farmers and substantial reduction of meat supplies.

In areas where meat and fish are scarce, proteins can be provided by poultry and eggs. But, often these products are terribly expensive. In certain west African cities, for example, eggs cost $ 1·20 per dozen, which puts them beyond the reach of most people.

Fish is another food rich in proteins. In many regions, increased fish production could improve diets. Here are two examples : in Ceylon, the annual catch has been doubled simply by equipping 20 0 sailing boats with outboard motors ; in a village in Cameroun, the building of a large fish pond has provided food for nearly thousands of people.

There are a great many causes of malnutrition in the world. Here are some of the most important ones :

1. **Careless use of Natural Resources :** Man destroys the soil that feeds him. In Atrica, for example, as a result of bush fires and poor agriculture, whole areas have become sterile. Man cuts down the forests that protect the soil from damage by erosion of wind and rain.

2. **Primitive Farming Methods :** In many of the less developed countries, agricultural methods are out of-date and the farmers have only the simplest of tools. In certain areas of Brazil, for example, the Indians plough the land, as they did two thousand years ago, using a plough made from a twisted branch.

Do you know that there are areas in the world, some of them as large as Europe, where the only available farm implement for digging, weeding, lifting and turning over the soil, is a short handled hoe ?

In addition, the crops they grow often have a low food value : manioc, millet of yams, for instance, are not as nourishing as rice, wheat or Soya. A farmer in Afghanistan or Iraq can barely supply his own needs, while a North American farmer produces enough to feed 20 people.

3. **Poor cattle Breeding :** One of the main causes of malnutrition is the lack of foods of animal origin—meat, milk, butter, cheese, etc. The countries most lacking in these foods are also those with the poorest pastures : in tropical regions, its takes 20 cows to produce the amount of milk produced by one cow in Holland, Ireland, Denmark or New Zealand.

4. **A Badly Developed Fishing Industry :** Oten, fishing is regarded merely as a local trade, and the huge resources of the ocean are neglected. Fish is eaten only in the neighbourhood of ports and fishing villages. Methods are out dated.

5. **Over Populated Land :** In the poorer areas of the world, over crowding is a serious problem. The population barely manages to stay alive on badly farmed land. Yet vast tracts of land still lie fallow: 50 percent of the earth's land surface could be cultivated, but only 10 percent is now producing food.

We all live on land in more senses than one. All our food and practically all our needs, mineral or otherwise, come from land. We are steadily getting short of land and we are hastening the process by misuse. If we misuse land we are only cutting down our main support and advancing the date of world starvation.

Solution for Malnutrition

There is, however, much scope for further progress in the solution of malnutrition :

(a) Ascertainment of the fundamental roles of particular dietary constituents. Our knowledge roles of particular chemical constituents of the diet under different circumstances is only at its beginning.

(b) New sources of human food, such as food-yeast utilizing waste molasses and other products and protein directly extracted from green plants, require further investigation.

(c) The development of methods of cooking and preparing foods for large scale catering in order to achieve the palatability attainable by the best cheps working on a small scale.

(d) Changing the habits of the people, so that more meat and fish may be included in the diet of the people.

(e) More manuring of the soil to enable greater yields of crops.

(f) Bringing new areas under cultivation by extending irrigation facilities and clearing forests where necessary.

(g) Scientific improvement in agriculture to enable better yield, or reclamation of lands at present lying barren.

(h) Introduction of minor irrigation schemes like construction and repair of wells, tanks, channels, small dams, tubewells etc.

(i) Plant protection and anti-plant disease schemes.

(j) Development of Pisciculture: Fish is the raw material of various industries: fish canning; fish salting; herring pickling; the manufacture of fish meal, which is a useful feeding stuff for poultry, pigs and cattle, and of fish-manure, and the production of oil of various grades from medicinal cod-liver oil to cruder oils used for such purposes as tanning, soap making and tempering steel.

(k) Development of animal husbandry or the dairy industry of other forms of animal industry, like meat-packing etc.

CHAPTER 27

RESOURCE REGIONS

The aim of Geography of Resources is to study the surface of the earth resources in relation to their utility by man. Man's material progress depends partly on the resources of that part of the earth which he inhabits and partly on the *will* or scientific development which he has acquired from his ancestors. Under the influence of the stimuli provided by or as result of the efforts man makes by satisfying his wants, the material or cultural environment is created. Land is cultivated, irrigation is provided, industries develop, rivers are bridged, roads and railways are built, towns grow and there is the whole paraphernalia of modern civilization that is born simply out of man's efforts for satisfying his "bundle of wants."

Definition of Resource Region

An resource region is not just a natural region which is differentiated in terms of physical environments by such factors as landform, climate and vegetation, or a physical region such as valleys, plateau etc., but is a homogeneous area of physical and human resources on which economic activities of man depends. We know that there is a definite relationship between the physical and human resources in different regions of the earth. Regional differences are quite obvious from the fact that one resource region is rich in organic resources while the others in inorganic resources. One region produces large amount of biotic resources while the other may be rich in mineral resources but third is lack in agricultural resources. No region on the earth fully satisfies all the requirement of human beings.

Criteria for Resource Regions

Any classification of the resource region must be based upon the following criteria :

1. Location and adequacy of resources,
2. Distribution of people and population structure,
3. Income per capita,
4. Distribution of natural resources,
5. Availability of resources,
6. Technological Development,
7. The nature of economic activities,
8. The degree of stability of native economy,
9. Accessibility and the role of transportation,
10. Social aspects.

On the above mentioned criteria the following types of resource regions are by no means exhaustive. They can serve, however, as a starting point which would guarantee that nothing important has been omitted. Other types may be added if required in order to arrive at complete scientific investigation in resource regions. Certain criteria, features or indices in the scientific investigation may also be supplemented. When proceeding from Macro-regions to Micro regions, one must apply increasingly more precise measures and indices as far as available data would allow. In general there may be a great variation in the types of resource regions and there can be many types of regions, depending on the purpose of the classification. In addition there is usually some intuitive choice of indices which often are of decisive importance.

In typical consideration natural resources usually form the background or basis of man's economic activity. On the other hand it is known that natural resources alone does not necessarily define the types of resource region. In similar or even in the same ecological conditions, different types of economic features are being developed depending on the availability of resources and on the standard of technology applied. The small country of Kuwait can serve as an example. Through the application of modern technology of power resources that country is far more advanced economically than adjacent Iraq and Iran, where use of age old machinaries produces much smaller returns. No doubt in addition to availability of natural resources, external economic, social or technical conditions exist in differentiation of types of resource regions formed in a certain territory.

Nearly every country has areas which have not participated fully in the man stream of development by virtue of their isolation, limited resources or declining resources, in accessibility. changing technology and other factors. Such problem areas of unemployment or under development should be and have been in many instances the object of government policies of investment and resource development. Thus adequacy of natural resources and technological development reflect to a large extent the characteristic or limitations of resource regions. On the above mentioned criteria a brief survey of the world's resource regions is made in the following pages :

Major Resource Regions

On the basis of certain criteria the whole world is divided on the following resource regions. These are :

1. Regions of Bounty Resources,
2. Regions of increment,
3. Regions of Efforts,
4. Regions of Retarded Development,
5. Regions of Arrested Development,

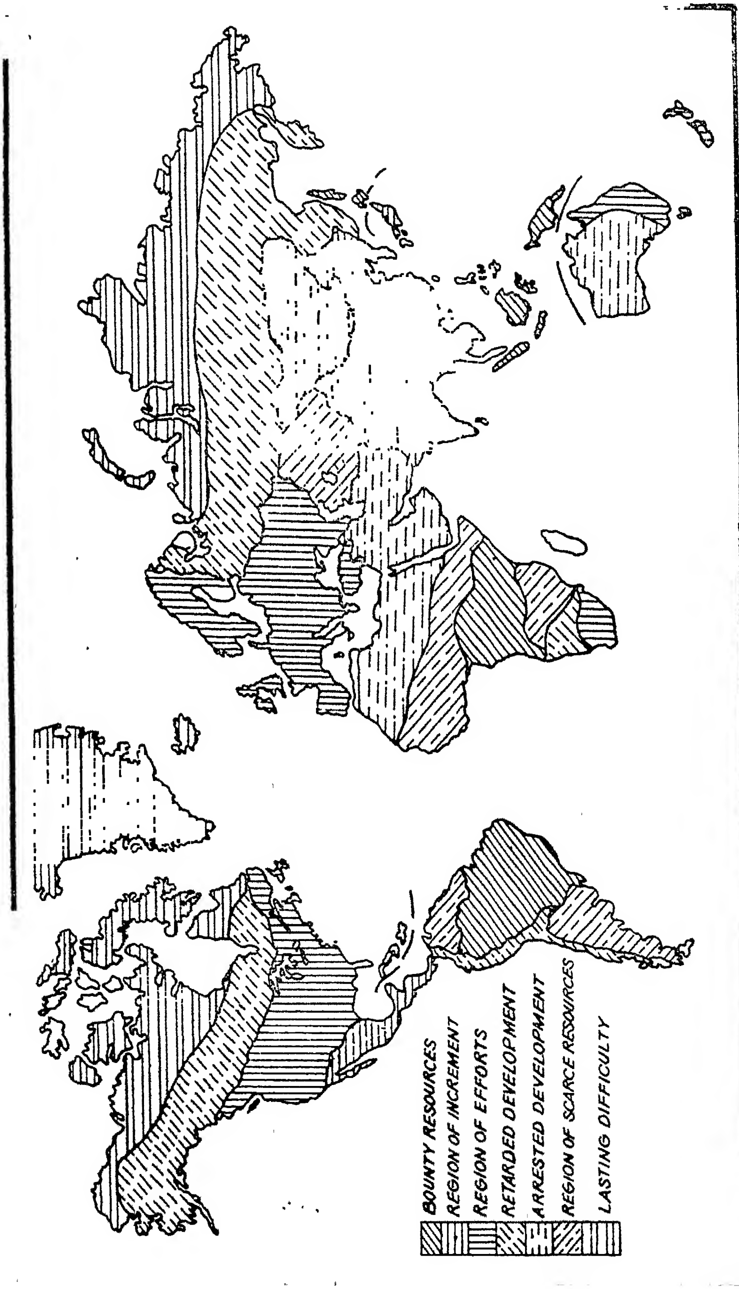


Fig. 27·1. Resource Regions

6. Regions of resource scarcity,
7. Regions of lasting difficulty.

REGION OF BOUNTY RESOURCES

Region of bounty resources extended over the East Indian archipelago, Indonesia, central parts of Africa and South America. Here nature is bountiful and man is mere gatherer rather than the active producer of things he requires. The heat is great at all seasons, and thus—though the region lies in what is known as the belt of Equatorial calms—there is a constant indraught and ascension of air. The heat, moreover, increases evaporation, so that the air is moisture—laden and the rainfall heavy. Near the Equator, in fact, rainfalls almost every day, often in thunder showers. As the heat belts shifts north and south of the Equator with the seasons, a summer rainfall is brought in turn to regions on the northern and southern limits of its sway, and a double rainy season to those parts which are twice traversed by the belt. The length of the two rainy seasons, and the time between, vary with the latitude, and near the Equator the interval between them is shortest.

The moist atmosphere, combined with heat, supports a luxuriant vegetation and near the rivers the foliage of the forests in sometimes so thick as partly to obscure the day light. In many cases the trunks of the trees are hung with parasitic plants and interlaced with climbers.

Biotic resources

This bounty resource region is the exclusive home of the hippopotamus and the giraffe, tallest of living animals. The elephant and rhinocerous are common also to the region of increment. Swift-footed, graceful and fantastically striped Zebras and quaggas frequent the grassy plains of all the bounty resources regions the most widespread and characteristic are the antelopes, which gallop in vast herds over the plains, and, ranging in size from an ox to a rabit, inhabit bush, forest and desert as well. Apes-narrow-nosed, tailless creatures of the monkey kind—are very common in all parts of this region. The bounty resource regions are the home of the most highly developed and fiercest apes, the Gorillas and Chimpanzees. The ostrich, the largest bird now existing, is typical of Africa, being found in all the open plains and deserts both in the north and south.

Forest resources

The prevailing vegetation consists of tropical forests which are extremely luxuriant and difficult to penetrate on account of the interlacing creepers and parasitic plants. The trees are evergreen, and the thick foliage partly shuts out the daylight, and gives the forests a gloomy aspect. Along the low coasts the prevailing trees are man groves, the roots of which are partly above the ground, but covered with water at high tide. The trees of most economic

value in the tropical forests and the palms, from which oil is obtained, mainly grown along the Guinea coast, the trees and creepers which yield rubber, notably those of the Congo basin, and the banana, the fruit of which is an important article of native diet in some parts.

Mineral Resources

Oil is found in South East Asia. Copper, gold and diamonds are mined, the chief copper mines being in the Congo Republic etc.

Human Resources

Despite its gloom and unhealthy climate, the region has a fair native population; but it has been reduced by the slave traffic of the past and the cruelties attendant on a forced labour system. The slav traffic was mainly associated with the ivory trade carried on by the Arabs; for the natives were captured and forced to convey the ivory—obtained both from elephants and hippopotami—to the coast free of cost,and were then sold. The forced labour system was chiefly associated with the rubber trade, organized by European and by it the natives were compelled to collect and bring into various stations a certain amount of rubber every year. The chief abuses of this system have now, however, been removed.

The great majority of the natives are Negro, which predominate over Africa. Nearly all the population are heathen, but different tribes have attained to different degrees of civilization. They live chiefly on bananas, yams, maize, and other crops, grown in clearings on the edge of the forest, and dwell in huts made of stakes or reeds.

In this group of countries has a low level of average income per capita with sufficient natural resources and is regarded as poor. In value of the valuable bounty resources and raw materials, these regions comprise the greatest reservoir of wealth and make an overwhelming contribution to the world's business today.

REGIONS OF INCREMENT

This resource region is very similar to the first described region. This resource region is characterised by comparatively high temperatures throughout the year, and an alternation of a dry and a wet season. The seasonal range of temperature is considerable.

The regions where a climate of this sort occurs are not numerous, and with one exception (in Southern United States) they are, so far as known, not very extensive, but they are of peculiar value and importance because the climate is the only one in which three of the modern world's most valuable products, cotton and rice and sugarcane, can be successfully cultivated under natural conditions. The value of regions enjoying the special conditions is of course, enhanced when the variability of amount of rain from year to year.

Soil and agricultural Resources

Those areas which are covered with the black soil due to the

decomposition of basaltic rocks do not, however, stand in such need of irrigation, for this soil, owing to its clayey nature, is able to retain moisture for a long time. It is extremely fertile, and especially suited for growing cotton, on account of the lime it contains. Millet, oil-seeds and wheat are also cultivated. Rice is most important crop. Small crops of tea and coffee are grown on the hill slopes and southern ranges, and pepper along the Kerala.

Forest Resources

The natural vegetation of this resource region is complex rich and variegated. In the general way the distribution of forest resources follows the rainfall, topography, soil and meteorological conditions. Most important species are sal (shorea robusta) Acacia Catechu or Khair, and Teak. Large tracts of this type have also been cleared for agricultural purposes and the forests in the neighbourhood have suffered from severe biotic factors such as overcutting, over grazing and fire.

Mineral Resources

The mineral wealth of the plateaus of this resource region have not been fully developed, both coal and iron occur, but sphrately, and the latter is widely scattered deposits. Gold is mined in many parts of this resource region.

Human Resources

In most parts of this resource region population is dense and is supported by agriculture. Nowhere, however, is the population evenly distributed. The people live mostly in villages and have almost clan type of social organization.

From an economic point of view this second resource regions could be classified in broad terms as developing countries, although in some other, particularly large countries of this group in which income of the population falls below the average national income of that country.

REGIONS OF EFFORTS

The countries of this resource region reach very high levels of average real income per capita. To this group belong the economically highly developed countries which are located in temperate zones, are rich in natural resources and are populated with various stocks. Examples are United States of America, Canada, North Western European countries and the U. S. S. R. This group represents a rich, upper class of nations of the world.

The climate of this resource region is characterised by a mild winter and a mild summer. Snowfalls occasionally for a month or two of winter, but seldom remains long on the ground. In addition to the slight seasonal variation, the daily range of temperature is very small in winter and only moderate in summer. The areas of this resource region are in the most favoured part of the westerties, for owing to their windward exposure they are

exempt from extreme cold in winter, and from aridity—the scourages of the temperate belt in the interior and east of continental masses.

This resource region is well suited to nearly all economic activities other than agriculture, for which only the less rainy areas are well adapted. This climate is the home and centre of the world's greatest industrial development. According to White and Renner, "climatic factors, such as variability, moderate temperatures and moist air have contributed notably to this achievement, but the presence of coal and iron, those nerves of modern civilization, easy acess to salt water, strategic and central geographical location, and the genius of the people themselves, have contributed as much or more than the climate. In short, progress has resulted from the intermeshing of physical and human factors".

The levels of per capita income in this resource region of countries vary greatly as there are great differences in actual economic level everywhere. There are, however, countries or regions among them, which are experiencing rapid agro-economic development.

REGION OF RETARDED DEVELOPMENT

This resource region of retarded development is mostly confined in the temperate zone. There is a permanent though sparse native population, there are settlements of various types, there are economic activities and there are prospecting and scientific activities of various kinds.

The climate shows most diversity. The contrasts between oceanic and continental conditions are marked. The climates of this resource region are characterized by considerable range in temperature between summer and winter. Range of temperature rather than range of precipitation marks the seasons. The warmest month has a mean temperature not below 10°C and the coldest month often has a mean below 0°C. Precipitation is not heavy as a rule and many occur at all seasons, with few exceptions or principally in summer.

Forest Resources

On the temperate parts of this resource region, where moderate warmth and moderate rainfall become covered with less luxuriant but very extensive forests, These are most extensively developed around the north of Great Lake's of North America in Scandinavia and as a broad belt from Carpathians, north eastward to the Baltic, eastward to the Ural mountains, and beyond them across Asia north of 45° to the Pacific ocean.

The warm temperate forests are composed of deciduous trees, that is, trees whose leaves winter and drop each autumn, the leaf laboratories being dismantled in the comparatively sunless months. Oak, beech, elm, ash, lime and many other kinds of forest trees, are found in their greatest luxuriance in this zone. Toward the pole, where the winters are longer and more severe, the deciduous

trees vanish, the hardy birch, with its silvery bark, reaching farthest north. Pines and firs, clad in small, hard, needle-shaped leaves, can alone resist the climate, and vast forests of these characterise the subarctic zone and the higher slopes of mountains.

The chief occupation is lumbering, or cutting down the trees and transporting the logs. Parties of men go into the forests every autumn and spend the winter in this occupation. The hard froest and the snow render it possible to cross lakes and swamps at that season, and to make roads in all directions along which the logs are allowed to float down the rivers in 'drives' sometimes extending for a kilometre in length, and men follow to prevent their hitching in the banks or creating great dams. Thus in time the logs reach some convenient place where mills have been established, and are landed and sawn up, or they are formed into rafis which can be towed by steamers till a suitable placed is reached for transferring the logs to ocean vessels for export.

RESOURCE REGION OF ARRESTED DEVELOPMENT

In this region economic progress is restricted and slow. In these regions man ekes out their livelihood in great difficulty. These regions are so named because in them the limit of maximum exploitation is soon reached, and further application of effort gives a diminishing return. Resource regions of arrested development are mostly confined in Hot desert regions of the world. This resource region is located about the latitudes 20° or 25° North and South, the chief representative areas being the Sahara, Arezona, South west Asia, the Atacama and western Australia. The sole criterion of the arrested development is aridity, the essential features being not the fact that rainfall is low but the fact that potential evaporation shall exceed precipitation.

Solar energy here falls on barren land, and not being absorbed by plants, spends itself in the work of heating air and helping to maintain the permanent winds of the globe, where carry rain to more favoured regions. Thus in a sense the existence of fertile lands is a consequence of deserts. Treeless plains are common in all regions of scanty rainfall and great range of temperature, such as the borders of the resource regions.

These regions are very sparsely populated. Oasis population are invariably dense, whereas true desert or nomadic populations are sparse indeed. Oasis are usually either scattered springs or places where streams descend from mountains and flow out upon alluvial fans.

The importance of the oases is, of course, the opportunity to obtain water for men and animals as they travel across the desert, or to maintain permanent homes in places where there is a water supply. In some respects oases seem to excel humid regions, probably because in places where water is obtainable the hot climate makes it possible to raise many crops each year. In

any event, the large oases of the Nile and Eurphrates rivers supported civilization long before there were civilized people in any part of Europe, and, at the oases in south western part of the United States, the Pueblo Indians developed a civilization far ahead of that of the aboriginal inhabitants of the rest of this country. The small oases, surrounding a single spring and with the date palm as the chief sort of vegetation ; support a small permanent population, as well as furnishing stopping peaces for caravans which must obtain water as they cross the desert.

REGIONS OF SCARCE RESOURCES

To this group, characterized by steadily increasing population belong, among others, large parts of south America, Soviet Union and most Prairies of North America. The region has a typical continental type of climate and is marked by great extremes. In winter cold waves may sometimes reduce the temperature to —· °C. in many places, while in summer the temperature may go up to 20°C. High summer temperatures, scanty precipitation and rapid evaporation conspire to eliminate arbroescent vegetation from all but strictly riverine locations where either surface or underground water is available. Hardy grasses thrive in the more humid parts of the arid regions, their characteristics depending upon both the amount of precipitation and the soil conditions.

According to Miller, "Grassland is often the dominant association even where climatic conditions favour forest, but except in continental interiors it can always be ascribed to inhabitions, *e.g.* strong winds or fires. It has been claimed that even parts of the Prairie and steppe could support forest, but that the trees have been destroyed by fire and bison. Along the forest margin the grass is fairly rich, but in the direction of greater aridity the cover becomes less continuous, open patches of bare soil appear and wider and there is a steady degeneration towards desert. At first the stronghold of pastoral nomadism, these steppes and Prairies have been recently brought under cultivation, especially where good communications allow extensive cereal growing *e.g.* along the trans-Siberian and the Canadian trans-continental railways. The trend of economic development and the great increase of population during the last century has focused attention on the problem of cereal food supply, and it is particularly in these sub-arctic grasslands that the greatest advances have been made."

Important agricultural resources are wheat, oats, rye, sugar-beet etc. Several qualities of the climate combine to give them great advantages for cereal growing : the early summer incidence of arinfall, the rapid rise of temperature in May and June, the hot summers with July means of 12°—14°C and mean maxima of 15° - 17°C the long hours of daylight, the sunny skies of summer, and the day air of autumn. The aridity, the length and severity of the winter, and the shortness of the summer, despite its warmth, were elements which did not after great possibilities for wheat

cultivation under the conditions that obtained fifty years ago, but the almost yearly improvement in quick-growing and drought resistant varieties promotes an ever-increasing area to the position of potential wheat-land.

The regions of scarce resources are dry in summer, however, when they are in the belt of the descending air of the horse latitudes, or the northern edge of the drying trade winds. On this account it is necessary to practise irrigation in order to carry on agriculture, chiefly because the regions of steppes are apt to have their rainfall in the wrong season of the year. Russian Turkistan, by way of illustration, has rainy winters and dry summers. Therefore the Turkish farmers irrigate their crops, which are growing in summer at the time when the moisture is deficient. The lands of this resource region are usually too dry for trees, but grass grows upon them and the curing of this grass to natural hay during the warm, dry summer makes good ranges of cattle. The steppes and the Great Plain's of North America furnish an illustration of the best grazing industry.

REGIONS OF LASTING DIFFICULTY

At present this resource regions are of little economic importance, except in areas where mineral resources are found. The natural resources of all these regions are scanty and monotonous. In every primitive stages man has to depend more on nature than on his own labour for maintenance. The hunting and graziers of this regions were absolutely dependent on nature and they had to search about some rich tract where she is very bountiful. As soon as the one, where they live, shows signs of exhaustion they will shift to another. Perchance if they found an extraordinary rich pasture they took up their semi- or permanent abode.

These regions have a continuously low temperature, except for a very short summer. The mean of the warmest month is under 10°C., and that of the long winter well below 0°C. In Antarctic regions the annual summer mean is below —5°C. Precipitation is about 254 mm. a year. In this climate the cold deserts of the world occur. The winters are long and severe and summers short and warm. Summer days are very long and nights correspondingly short. The most striking feature of the Sub-Polar climate is the absence of forest trees. The main reason for the typical absence of trees is the shortness of the growing season and the fact that the warmest month averages no more than 10°C. Here are found several varieties of woody plants, including the ground birch *(Betula glandulosa)*, Labrador tea *(Loedum Spp.)* Arctic willow *(Salix arctica)*, various berry bushes *(Vaccinium spp.)*, Arctic heather *(Cassiope Spp)* and certain rhododendrons.

All places with this type resources regions have a low sun during most of the year. Indeed, during mid-winter, daylight disappears altogether for a while, though nights of dense darkness are rare. Even during the dark period, Eskimos, Samoyeds, and other

denizens of the Tundra, carry on their sledging, hunting, grazing and fishing, though obviously encountering greater difficulty than in summer.

All occupants of regions of lasting difficulty mainly came from Asia and all posses Mongoloid characteristics have much in common. Those who inhabit northern Scandinavia, northern Finland, and northwestern Russia are called Lapps and like their neighbours to the east—the Samoyeds, Tunguses, Ostiaks, and others—are apparently of Mongoloid stock. Those who occupy eastern Siberia, northern and north western Alaska, northern Canada, Labrador and Greenland, are called Eskimos.

Lapp herdsmen are found in the North of Norway, Sweden and Finland. They follow the herds of reindeer in their annual migrations from the edge of the forests to more open country. The herders and their families live in tents made of a framework of birch poles covered with cloth or skins. Smoke from the fire beneath escapes through the hole at the top of the tent.

The people who live in Canadian frozen wilderness are the Eskimo, and they got everything they need from the sea, for, though it freezes on the surface, it does not freeze below, and in the unfrozen water there are always plenty of fish and plenty of the little creatures on which fish feed. Animals that we think of as living on land take to the sea. There is the polar bear, for instance. It can walk, but it can swim much better. The seal is much more at home in the water than on the land. The whole, which looks like a fish, is not really a fish, at all. It breathes like a land animal, and actually has legs, through these can be seen only in the skeleton. Almost the only land animal is the fox ; but it lives on birds that feed on fish, so that the fox, too, really gets its food from the sea.

A surprisingly large number of animal resources, including the musk-ox, arctic hare and lemming, brave the rigour of winter, seeking their food in the vegetation (e g. reindeer moss), which is buried under only a thin mantle of snow, since precipitation is everywhere light. The sea is a great source of food, and many animals resources e.g. polar bear, derive their winter food supply from this source; even the reindeer is said to make shift with seaweed when nothing else is to be had. But the winter is hard and when the polar night is nearing its end, when food is scarcest and the cold is greatest, they are reduced to a very poor condition and numbers perish.

According to Austin Miller[1] "The life of man is a constant struggle against nature ; by necessity a food-collector he is often a fisher as well as a hunter, for the summer is too short to store up food against the long winter. Fishing, in fact, plays such an important part in his life that settlement in the higher latitudes is almost restricted to the coast. The seasonal change of habits necessitates

1. Op. cit., p 247, 1953.

a nomadic existence, the summer home is the portable tent of skins, the winter home a more permanent structure of earth or snow. It should be remembered that constructional materials, especially wood, are scarce and the native must utilize what is to hand, hence the 'Igloo' of the Eskimo. In summer the rivers and the sea are the chief media of transport (in Canoes), for much of the land is swamp, in winter the sledge drawn by dogs or reindeer, for the frost converts river, land and even sea into a uniform medium."

He eats Seal, Whale and Walrus. From the Fat of these animals he gets oil for light and heat, from their skins he gets his clothes. According to W. Elmer Ekblaw, he eats when hungry, drinks when thirsty, and sleeps when sleepy—no schedule for him. Nevertheless they have adjusted themselves to their physical milieu in a masterful fashion. Their dwellings, boats, sledges, harpoons, bows and arrows, and clothes are remarkable adaptations to Nature.

The northern portion of the region is known as the Polar ice cap. The climate of these regions is usually referred to as the Polar ice cap climate. Scientific data on meteorological statistics of the Polar ice cap are far from adequate but observations already made reveal that the interiors of Greenland and Antarctica are very cold indeed during midwater. The recent observations have justified earlier views about the presence of an anticyclonic ice circulation (circular movement in a clockwise direction) in the eastern part of the Arctic ocean, and proved that in the western part there is a cyclonic circulation (anti-clockwise) The Lomonosov Range is an approximate boundary of these circular movements.

The work done by the recent Russian expeditions in 1952, has confirmed earlier views about the peculiarities of the atmospheric conditions in the Arctic. The theory that there is a continuous cap of high pressure over the central part of the Arctic ocean was definitely rejected, along with the idea of persistent anticylonic weather in the aiea near the Pole. It has been proved recently that the meteorological conditions here change very frequently.

The data regarding the penetration of warm air from the Pacific Ocean to the high latitudes through the sea of Okhtsk and the Bering Sea are very interesting. This warm air sometimes spreads above the stratum nearest to the earth, i.e., the cold stratum measuring some 195 m. Over the whole Troposphere to a height of 6 to 8 kilometres, embracing the entire region adjacent to the Pole.

Active cyclonic movement, its considerable seasonal durations, the interaction of the cold Arctic air with the warm air from the Atlantic and Pacific oceans, the peculiar processes of regeneration of the air-mass during the polar days and polar nights—such were the new data were obtained by the Russian recent expiditions, which helped to change the incorrect views about the polar ice cap of cold air.

Various Exploration in regions of lasting difficulty

Arctic exploration began shortly after 9th and 10th centuries. "The great Arctic island was discovered by the Norwegian, Eric the Red, about A. D. 980. In 986, a small Norse Settlement was planted along the south-west coast. Later, numerous other settlements were made. For some 450 years these Greenland settlements existed and continued to trade with Iceland and the mother country. Shortly after 1400, intercommunication ceased and all trace of the Greenland colony was lost."[1]

But Russians appeared on the coast of the white sea as early as the 9th and 10th centuries. Some time later Russian fishermen or 'pomors', who had settled on the white sea coast, discovered Novaya Zemlya, Grumant (spitsbergen) and sailed regularly to and from these islands. Ice and frost did not deter the advance of the Russian seafarers to the north and east. Sea-hunters and sealers improved ships, gained experience in navigating ice-bound seas and gradually settled the Far North. The town of Mangazeya on the coast of Taz Bay was founded in 1601 by Russians who inaugurated regular trading relations with the inhabitants of Siberia.

Finds made by archeologists in 1940 on the east coast of the Taimyr Peninsula proved that, not later than 1617, Russian explorers, advancing eastwards, rounded the most northerly cape in Asia—Cape Chelyuskin—thus going through the western part of the Northern Sea route.

In the first half of the 17th century the Russians began to settle in and develop Siberia and the Far East. In 1648 Semyon Dezhnev and Fedot Alexeyev (Popov) passed the north-eastern extremity of Asia—now known as Cape Dezhnev—being the first to sail from the Arctic ocean into the Pacific; their voyage established that Asia was not linked by land to the American continent. Thus by the middle of the 17th century Russian explorers had sailed in parts the whole of the Northern Sea route, from west to east.

The voyages and expeditions of ordinary Russians—sailors, sealers and cossack frontiersmen—in the 16th and 17th centuties opened to mankind a region where climate and other natural conditions are about the grimmest in the world. They worked heroically in the darkness of the long polar night, and, braving storm and blizzard, penetrated the vast uninhabited territory and mastered the formidable pack-ice. Hundreds of nameless pioneers perished in the battle against the harsh conditions of the Arctic.

The Russian voyages to the Arctic in the 16th and 17th centuries stand out also for the reason that the important geographical discoveries of British, Dutch, Spanish and Portuguese sailors in those times were, in the main, made in southern latitudes where conditions are much easier than in the polar area.

During the 18th century the most important undertaking was

1. White and Renner, op. cit, p. 267.

the Great Northern Expedition, which lasted ten years—from 1733 to 1743. It was Peter the Great's idea, and both in scale and results achieved was the greatest Arctic expedition of the pre-Soviet period. The great Northern Expedition explored a vast territory in the north of Russia, starting from the white sea in the west and ending at the sea of Okhotsk in the east.

Russian exploration at the end of the 18th century and during the 19th century extended not only to the coastland of the Arctic ocean, but spread to higher latitudes. Hydrographical Survey and the mapping of Novaya Zemlya brought fame to Pakhtusov and Tsivolka (1834–35). A young naval officer named Litke made four voyages to Novaya Zemlya (1821–24). He was one of the organizers and the first chairman of the Russian Geographical Society, founded in 1845.

Towards the end of the 19th century progressive people in Russia stressed the advantages of opening the Arctic seas to navigation and of the economic development of the North. Much was done in this respect by the merchants Sidorov and Sibiryakov who took an active part in the organization of polar investigation.

In 1937 expedition to the North Pole proved that the aeroplane could be used for landing on the ice of the centrae Arctic, today, when polar aviation has made such giant strides, the aeroplane has become the most reliable and convenient means for penetrating the most inaccessible regions of the Arctic.

In the 1954 expedition, seventeen years after the first flight of Soviet airmen to the Pole, airmen of all ages were flying over the expanses of the Arctic.

Scientific values of regions of Lasting Difficulty

As a result of the work done recently by various expeditions many secrets of nature in the regions of lasting difficulty have been disclosed and a number of conclusions of great practical importances have been drawn. But much remains unknown and mysterious, and research workers of this resource region have much to do in order to wrest all its secrets from the Arctic and understand its nature.

Among the important successes of the Arctic explorers during the years 1947–53 mention should be made of the cartographic work carried out by aerial photography. As a result of this work, which demanded great initiative, self-sacrifice and courage on the part of the members of the Arctic expeditions, the previous maps of the Arctic had to be changed radically. Many of the geographical points on the old maps were shown dozens of kilometres away from their true position, and as regards heights, mistakes of hundreds of metres were made in a number of places.

A number of new small islands have been discovered close to Severnaya Zemlya, near Sergei Kirov Islands and in other areas. Six new, islands were found near Demyan Bedny Island; three new islands have been charted in the vicinity of Kirov Island. Thus,

the most northerly, least explored, and most remote lands have found their proper place on the map.

The explorers carried out a yearly cycle of observations and collected varied scientific material of great value. The two stations made more than ten thousand meteorological observations. It is probable that the polar ice caps will be the sites of permanent weather stations in the future. In 1940, the Germans established a secret weather station in eastern Greenland in order to gather long, range data on the weather for use by their air-forces in western Europe during world war II. With the aim of testing the higher strata of the atmosphere nearly three thousand radio-sondes and pilot-balloons were released and more than two thousand observations were made of solar radiation. Soundings for depth were taken at more than a thousand points, dozens of prolonged deep-water hydrological tests were made with the object of measuring the speed and defining the direction of currents, taking the temperature of the water and samples for hydrochemical analysis. Numerous specimens of sea-bottom deposits and of vegetable and animal life were collected by explorers. The direction and speed of the ice drift were regularly observed and specialists carried out tests of the physical and chemical properties of the ice. Many important questions were still unsolved, despite the success of various expeditions, tapping of the resources of the Arctic remained a matter for the future.

From the above discussion and in spite of considerable differences in resource development between various resource regions generalization can be made, namely :

1. that there exist in the world a small group of highly developed countries who utilized every types of natural resource for their socio-economic development and a much larger group of sometimes extremely poor countries ;

2. that the group of highly developed countries has an established pattern of agro-industrial development, while on the average the progress in the poor group of countries is slow and is hampered by the rapid growth of the population ;

3. some of these developing regions possess a very good potential for development of natural resources for future utilization of wants ;

4. that the levels of income among countries regarded as poor change greatly from one to another ;

5. that the relationship between the resources and population is usually much more unfavourable in countries regarded as poor, that population trends in such countries are more dynamic; and that they do not have at their disposal an international capital market nor outlets for emigration.

CHAPTER 28

CONSERVATION OF NATURAL RESOURCES

Meaning of Conservation

Conservation means wise use of the world's natural resources efficiently to produce the greatest possible benefits to man over the longest possible period of time.

The natural resources are, basically, air, water, soil, vegetation, animal life, minerals and human resources. These form a pattern on earth that utilizes and distributes energy from the sun. Without them, man could not live To insure a steady, lasting flow of materials and energy from these resources, man has found that he must use them wisely and without waste, and must maintain or replenish them whenever possible. This is conservation. It is more than just preserving or saving, or a *denial* of use. It is wise use. It is use without depletion or, in the case of minerals, with minimum depletion.

The earth's resources provide nearly everything needed for life. Resources have value only if used. Conservation promotes proper use so as to insure a continuous supply of resources for the future generations

Why conservation ?

Conservation is not a new concept. Crop-rotation and game-protection principles have been followed to some extent since the beginnings of civilization. But the idea of practising conservation on a widespread scale dates from the nineteenth century when the human population began to increase rapidly. Man soon realized that the natural resources he thought inexhaustible were actually being depleted at a rate dangerous to the future existence of mankind. The need for a serious, organised method of conservation became evident.

Human beings depend upon the resources of the earth for most of the basic needs of life. Each generation of people has a responsibility for using the earth's resources in a way which will assure a continuous supply for future generation.

The problems confronting mankind—the population explosion, man's destruction of his natural resources and the pollution of his environment, the usually peace gained only by the big powers fear of each other.

Methods of Conservation of various Resources

The dangers threatening the natural resources and steps taken to over come the dangers can be explained in a perhaps oversimplified manner as follows.

SOIL CONSERVATION

The thin, fertile layer of topsoil that grows most of the important crops of the world is seriously depleted by driving rains and winds when it lies exposed to those elements. In this part of the chapter, however, we are concerned only with the measures for control over soil erosion, which is one of the most serious problems facing all over the world.

Major Causes of Soil Erosion

Large areas in all parts of the world have been rendered useless as a result of soil erosion and areas which suffer from moderate or slight erosion and whose productivity is reduced as a result of soil losses are very much larger still. Sheet erosion, which consists in the washing away of the fertile top layers of the soil, is the most extensive form of erosion, occurring even on moderately sloping lands. It causes enormous losses to agriculture every year by reducing the productive capacity of lands. Gully erosion, which generally starts after sheet erosion has remained unchecked for some time, has already rendered large areas useless, and is steadily increasing.

The most important cause of soil erosion is destruction of forests and other vegetation from sloping lands, desert margins and other areas susceptible to erosion. Vegetation acts as a protective cover against the forces of wind and water, protecting the soil from being washed or blown away and preserving the physical and hydrographic balance of nature.

Forests for example, provide the most effective protection against erosion on hill slopes. They break the force of runoff by impeding the flow of rain-water down the slopes and by absorbing large quantities of it in their dense mat of undergrowth. This absorbed water flows away slowly over a period of time ; a large part goes into the soil, flows undergrounds, feeds springs and streams and is available for utilization in the foothills and plains. In this way, the hill slopes are protected from soil erosion, the flow of streams is regulated, the danger of floods is reduced and sufficient quantities of water are available in dry periods. But, when the protective cover of forests is destroyed, thus natural balance is disturbed. Rain water flows down the slopes unimpeded at great speed and carries with it large quantities of soil and other loose material. The hill slopes are denuded of valuable soil and lands in the foothill zone where this unassorted mass of sands and gravels is deposited are in turn rendered unproductive. Most of the water flows away during the rainy periods with the result that on the one hand floods are more frequent and more severe and, on the other, little water is available during the dry periods.

Destruction of trees and natural grasses in dry areas has similar harmful effects. Trees act as wind-breaks, reducing the force of the wind, and the grasses bind the sandy soils. But when such

protective vegetation is destroyed, the sandy soils, exposed to the full force of the wind, begin to be blown away. Large areas in the marginal zones of deserts are thus rendered unproductive by the deposition of sand.

The causes of destruction of forests and soil erosion, and the nature and severity of the erosion problem vary greatly in different parts of the world. In some areas as in the forests of Africa, Asia and South America, shifting cultivation, which is practised by the tribal people living in these areas, is a major cause of destruction of forests.

Unregulated grazing is the cause of destruction of forests and consequent soil erosion over large areas in all parts of the earth. In the Alpine—Himalayan mountain system, for instance, grazing by cattle, sheep and goats is the most important cause of depletion of the vegetation cover and soil erosion. Similarly, over large parts of grasslands, the destruction of forests and soil erosion are due mainly to over grazing. Fig. 28·1. shows the intensity of soil erosion in various parts of the world.

Sound methods of soil conservation

As men are so dependent on the soil for the supply of food, fuel and fibre, it is vital that great care should be taken to conserve, protect, renew and maintain soil fertility. Erosion control therefore, means either decreasing or diverting the runoff, or both. Thus, the possible methods are :

Reducing the Runoff by Making Soil Absorbent

The absorbing power of soils can be increased by improving the under drainage, by certain cultural practices and by the increase of organic matter and improvement of tilth.

Underdrainage of soils can be somewhat improved by the growing of deep rooted crops or crops with a tap root such as alfalfa or legumenons crops. The decaying roots leave channels that promote percolation of water.

Absorption of water can be encouraged by cultural practices. Deep plowing conforming nearly to contour lines slows up run-off and increases absorption of water. This is especially effective if a reversible or side hill plow is used and the furrow slice always thrown up hill. This position of the furrows causes a larger amount of water to find its way into the soil. The incidental benefit of this plowing is that the mechanical movement of the soil up hill partially counteracts removal to lower levels by erosion. In stilled crops ought to be planted on contour and cultivated only on contour.

Increase of organic matter and improvement of tilth by manuring and plowing-under legumes or hay crops promotes absorption of surface water to a remarkable extent. But to obtain permanent increase in organic matter under field conditions is a very slow process at best, and frequently on soils subject to erosion little

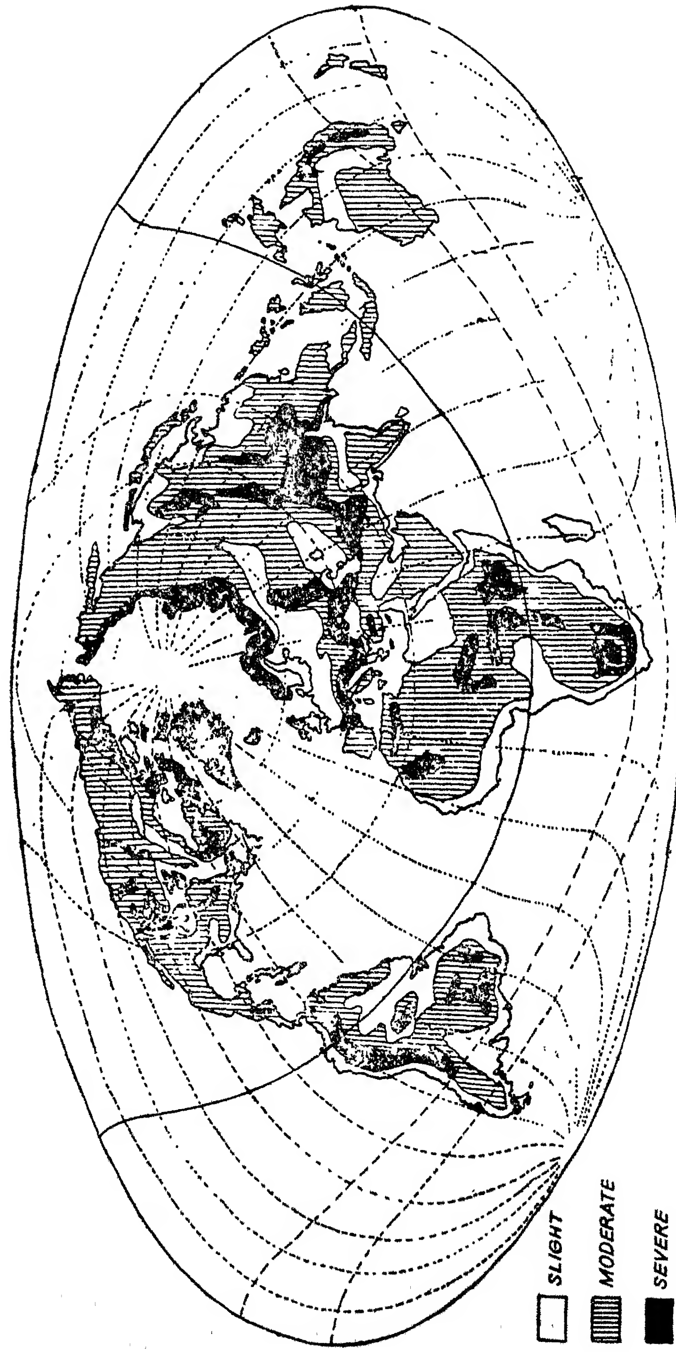


Fig. 28·1. Intensity of Soil Eronsio

progress can be made in this direction unless the erosion is first checked by some mechanical means.

KEEPING THE SOIL COVERED

Land utilization on farms in developed countries involve growing limited amounts of cash crops, hay, corn, and grain as feed for livestock and pasturage for cattle. The prevailing rotation is corn, grain, clover one year, or clover and timothy hay two years. A larger rotation in more limited use is corn, grain and alfalfa for three to five years. The first rotation is suitable for soils with a slope upto 10 percent, provided good soil management methods are used. On land in the steeper part of this classification, especially if on long slopes, special care in cultivation and use of erosion control devices is derivable. Land with 10 percent to 15 percent slope used for farm crops ought to be in the larger rotation including alfalfa. Land steeper than 15 percent ought to be kept in permanent pasture.

If farmers would remedy their soil problem and production costs, and apply the obvious remedy they would come to these standards more nearly than at present. They are accustomed to extensive practices, where as more intensive use of land would be just as profitable and better from the point of soil conservation. For instance, many farmers attempt to pasture some very rough stony land that is too droughty to justify such use. To make a large number of crop hectarage, they use areas of steep land suitable only for pasture. Following a soil improvement program, the same amount of cash crops and feed too livestock could be grown on fewer hectarages of the leveler land. The rougher parts of the land now cultivated should be added to the better parts of the pasture, the feeding quality and capacity of which can be greatly improved by proper fertilization and management. This would release the roughest land for timber.

The farm need attain no greater total production, but the net profits will be greater. The cost of better fertilization will be greater. The cost of better fertilization will be offset by less labour and wear on machinery, and the value of the rough land will increase with the growth of timber. The increase of the proportion of forest would in itself have an important effect in reducing the erosion problem.

After the land is put in use as here suggested, some other principles of good management need to be followed. On side hills of any considerable length, fields ought to be laid out in long comparatively narrow strips across the slope, so that the land in intertilled crops will alternate with stripes in various crops as shown in fig. 28·2. The reduces the area most subject to erosion and gives runoff little opportunity to collect. Rotations with the maximum of sod crop and the minimum of intertilled crops should be used. Permanent sod should be left in the depressions or side-hill run where considerable volumes of water collect and flow down the

slopes. Such strips build up when the field is in intertilled crops and washed may start at either side of the sod. This trouble is

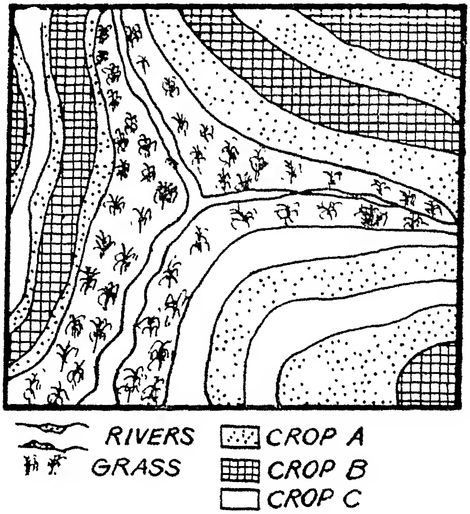


Fig. 28 2. Strip Cropping System.

reduced by plowing several furrows through the sod strip every few rods, leaving the sod in long patches rather than in a continuous strip.

All of these cultural and rotation practices have been advocated for years and adopted by many farmers in Japan, the United States and the U.S.S.R. but it is apparent even to the casual observer that soil is washing away much top rapidly. Much sloping land of mountainous region is still being used in a manner which will make it absolutely useless in a few years.

TERRACING

Terracing field lands to prevent erosion and conserve moisture has been practiced in the highly developed countries. Enough terracing has been done in many developing countries in old and new world since historic past to prove that this practice has an important place in soil conservation in large areas.

Terraces Control Runoff and Reduce Sheet Erosion

The power of flowing water to cut soil increases very rapidly with increased velocities in the slopes. For example on land with a slope of 6 metres, water flows with about twice the velocity that it does on a 1/2 metre slope. Doubling the velocity increases the cutting power more excessive. The increased volume of water and the cutting tools of soil particles in suspension furnish the cause of the maximum erosion near the foot of the steep slopes.

Terraces control this runoff because they are spaced in a

series like steps down the slope, each taking its share of water before the total quality becomes large enough to do damage. Slope may be cut into a series of terraces with sufficient level ground on each terrace for cultivation, and an outer wall at the edge to retain the soil and to slow down the flow of rain water down the slope as is shown in fig. 28·3. Since these terraces are built with a very flat slope, the water that each ·traps is carried in a broad slow-moving stream to the side of the slope without damage to the field. This slow movement keeps the water in the field for a long time, causing more of it to soak into the soil and reducing the runoff and damage to the lower lying land. Terraces are mostly used in Monsoon Asia, temperate and semi-arid regions of the world.

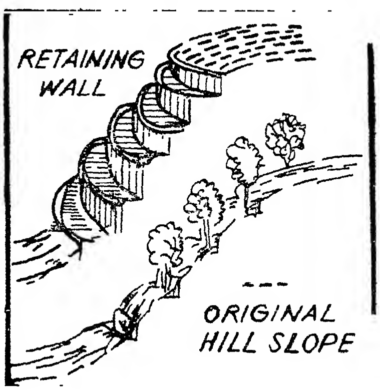


Fig 28 3. Terracing to prevent Soil Erosion.

Temporary Dams applicable as conservation method for small Gullies

Some small gullies are formed as the result of carelessness in cultivation by improper direction of crop rows, location of cattle paths, wheet tracks, dead furrows, etc. The small gullies formed as a result of such minor causes or incidents can readily be filled mechanically with plow, or plow and grader, and the larger ones by installing temporary structures that will promote fill by sedimentation. The most common method of filling small gullies is to place a layer of straw, corn stover or manure in the bottom and roll earth on to it by plowing from the sides. Sometimes a grader o r road drag is used in addition. The fill should be made higher than the land on either side to prevent its cutting out with rain while the soil is loose.

Temporary dams for the larger gullies that fall in this class can be made of straw, poles, stakes and brush or woven wire fencing. Several general principles must be followed in building any of these structures, which are illustrated in fig. 28·4.

(1) Use only low heads, not over two to there metres.

(2) Build the sides wall into the banks of the gully and some distance up the slopes to prevent cutting around the dam.

(3) Build the dam low in the centre to provide a spillway.

(4) The material should be thatched on the downstream side to form a gradual descent and avoid a damaging waterfall.

(5) Fasten the straw or brush in place by nailing bars or by wrapping heavy wire to posts that were set in a line across the gully on the side of the dam before placing the straw and brush.

(6) Get the gully sodded before this temporary material decays. Since these structures require labour and are only tempory, they are suitable only where the gullying is the result of minor causes of erosion or to secure fill where further gullying will be prevented by terracing.

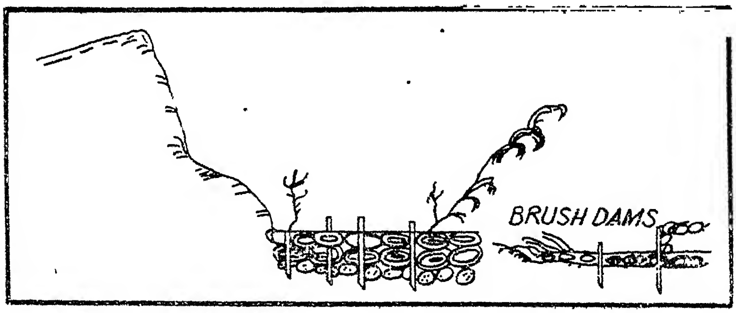


Fig. 28·4. The Bush dam to prevent soil erosion.

Earth-fill Soil Conserving Dams

In the extensive work in erosion control in various parts of developed countries, the soil conserving dam built with erosion—resistant conduit through the earth-fill has been stressed much more for this purpose than other structures it is :

1. The cheapest permanent structure.

2. It can be used to fill gullies by sedimentation. This feature is important because the farmer ordinarily does not start systematic erosion control until he has a gully that is bod and needs filling. Many men must discover the cost of repair before they appreciate the value of prevention.

3. Raising the head of the earth dam is simple and can be done whenever needed.

4. Control of the erosion at the outlet of the pine is a simpler problem than from notched overfall dams. Fig. 28·5 shows the earth drop-inlet soil conserving dam. Runoff water bearing its load of silt is ponded in the basin above the earth dam. Most of the silt settles to the bottom and the top layer of water flower into the inlet and down through the pipe into the gully below the earth dam. The earth fill dam should be covered with vegetation at the earliest possible time to protect it from washing.

Conservation of Rock Washes on Steep Hill Slopes

The run-off from many hill land fields finds its way down the steep, rough hill sides into the valleys. This steep gradient gives the water enormous cutting and transporting power, as evidenced by the fans or deltas at the outlets of such washes, composed largely of stones ranging in size up to a cubic metres and even more. When a number of such washes converage into one channel they

often cause considerable bank cutting in the lowlands, as well as covering bottom land with their debris.

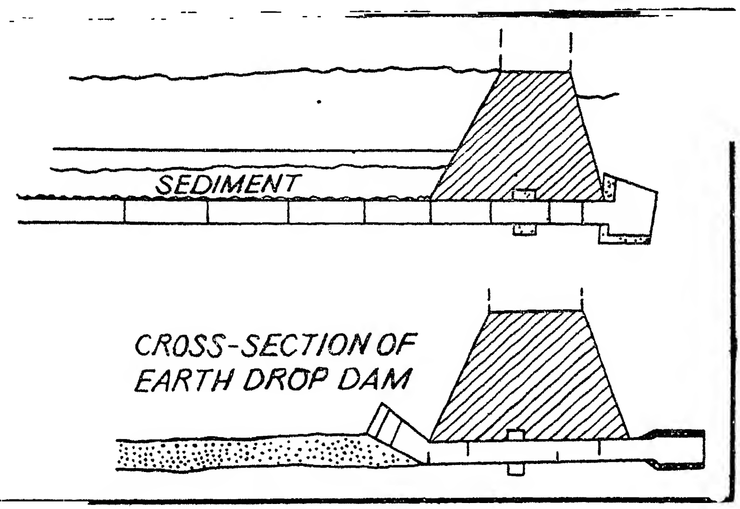


Fig. 28·5. Earth drop Converging Dam.

Two general methods of control have proved satisfactory. The entire wash or run can be lived with the floating rock to form an erosion-resident flume. The cross section (sea fig. 28 6.) may be rectangular with a flat bottom and nearly vertical sides, the height of the walls being determined by the volume of water to be carried.

The general method of control adapted to the larger gulches in the rocky bluff areas consists of a series of dams in the gulch which correspond to the risers of a stairway. Above each dam of concrete masonry or rubble there is a settling basin. At the foot of each dam an apron is necessary to prevent damage from the waterfall as shown in fig. 28·7. The dams are usually built with heads under four metres. They are placed close enough together to give the fill a gradient of about one metre per hundred The fig. 28·7 shows a series of such dams near Nainital and adjacent areas. These are constructed of quarried limestone without mortal.

SOIL CONSERVATION IN VARIOUS COUNTRIES

Steps for the control of erosion and conservation of soil have been taken for a number of years in certain advanced countries like the U. S. S. R. and U. S. A. etc. More recently, soil conservation work has been taken up in several other developing countries. But there has been no nation-wide effort in this direction so far, and even in developed countries, where the work has been going on, this has been on a very limited scale. The programme for soil conservation is adopted by various countries, though small in

comparison with the magnitude of the problem, marks the beginning of the world-wide effort to tackle it. There are many limitations to undertaking a larger programme at this stage. Very little work has been done on soil conservation so far ; data on such basic items as soil characteristics and type and severity of erosion in different parts of the world is lacking, and technical personnel with the necessary training and experience is limited and has to be drawn from many different fields.

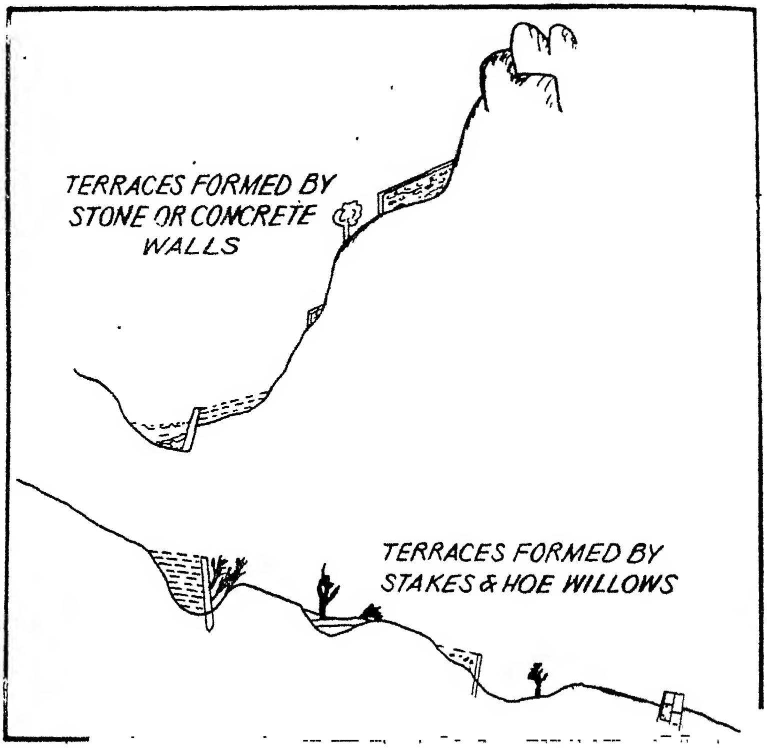


Fig. 28·6. Conservation of Rock Washes on steep hill solpes.

Water and Soil Conservation in the U S. S. R.

The Soviet Union is the first country who adopted the water and soil conservation practices. The Soviet Union is the first country in the world to have fixed a limit of exploitation of natural resources. Furthermore, there are laws for the protection of various resources. Thousands of Scientists were employed by Russian government to make surveys of various natural resources and to be responsible for the applications of various conservation operations. In this connection the Institute of the Academy of Sciences of U. S. S. R. has drawn up a programme of inter disciplinary research on the scientific principles that should underlie the

transformation of nature in the Soviet Union for better utilization of resources.

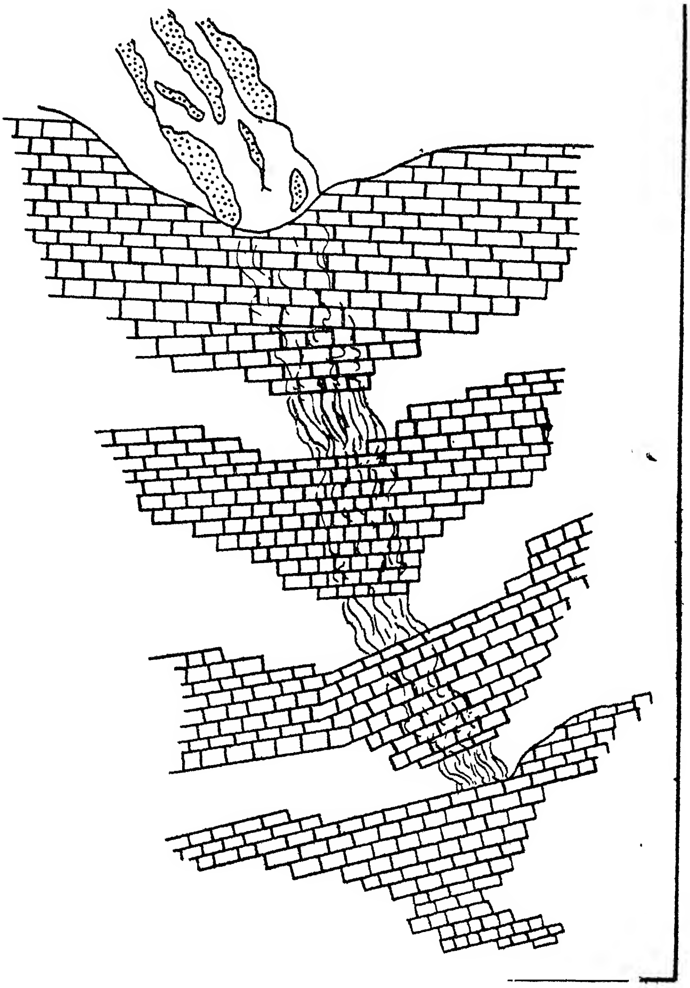


Fig. 28·7. Dam construction to prevent erosion.

United States of America

In the U. S. A. the soil conservation was initiated in 1899 as part of the research program of the department of agriculture. Cooperation was maintain with the Federal Soil Conservation Service which employed many men to make special soil surveys of individual farms and watersheds for guiding soil conservation. Then, in November 1952, the Soil Survey was transferred to the Soil

Conservation Service and all soil mapping was consolidated under the one Soil Survey.

U. K.

The first systematic soil surveys and conservation in the United Kingdom were carried out nearly five decades ago. The Soil Conservation Survey is financed by the Ministry of Agriculture and the general policy is supervised by the Soil Survey Research Board which was appointed by the Agricultural Research Council at the time of the reorganization.

Other European Countries

Until 1925, soil classification in France was based on geological features, the maps prepared, frequently called agrologic maps, varying in scale from 1 : 80,000 to 1 : 50,000 There were very few copies of these maps and a collection of them was destroyed during a bombardment in 1944.

At present time, a program for mapping the soils of France on a scale of 1 : 1,000,000 is proceeding and the first quarter sheet has been published.

In the Netherlands a number of institutions are connected with various aspects of soil classification mapping and conservation practices and with related investigations in other avenues of soil science. For the actual classification and conservation of soils from the national point of view, however, the Soil Survey Institute at Wageningen is of primary importance.

Australia

In Australia, the Soil Survey and Pedology Section of the Division of Soils of the Common Wealth Scientific and Industrial Research Organization (C S.I.R.D.) is the body responsible for the greatest amount of soil classification, mapping and conservation. Significant amounts of work in this field has been carried out in the past by Department of Agriculture and Forestry in Western Australia, Victoria, New South Wales and Queensland. At the present time, however, the only effective work being done by State authorities is in Victoria and Queensland.

African Countries

France was the first country who make soil survey and conservation in her colonial parts like Tunisia, Algeria, Morocco, Guinea, Togo, Madagascar, Mauritania, Mali, Niger, Chand.

Pedological mapping and conservation practices in Central African Republic and Republic of Congo is done under the auspices of the Cartographic Group of the Division of Agrology of the National Institute for Agricultural Study in the I.N.E.A.C.

SOIL CONSERVATION IN INDIA

Soil Conservation in India has not made much headway during the past two decades. Out of an estimated area of 175 million

hectares only 20 million has been covered. In the catchment areas of 26 river valley projects covering 70 million hectares, only 1·3 million hectares of a critical area of 16 million hectares has been treated. If the soil erosion in catchment areas continued their productivity and capacity to retain moisture would drop and reservoirs would suit up at an alarming rate. Droughts would menance catchments and areas down stream would be threatened with floods. Sedimentation, mostly from the black soil region, has eaten up about 60 percent of the capacity of Nizamsagar and the irrigated area has shrunk by 70%. The trend of silting is equally heavy in several other areas.

In Bhakra-Nagar, the average annual silting is 24935 sq. metre. The rate was assumed to be 8·10 hectare metre per 25 sq. km. a year and that observed is 113 hectare metre. The catchment area is 52000 sq. km. and the sediment deposited is 39901 sq. metre up to the last year since the construction of dam. The capacity is 3030 million hectare metre gross and 686 million hectare metre deat.

The sediment data from some other reservoirs are as given in Table 28·1.

Although Rupees 3,000 crores has been spent on 300 major and medium projects, the expenditure incurred on soil conservation so far is only Rs. 48 crores.

The sediment data of streams rivers and reservoirs are collected by five agencies of the Union Ministry of Agriculture and Irrigation, six of the Central Water Commission and five of the States. But data from only 433 sites have reached the Central Pool although there are 1,158 gauge and discharge sites in the country. There are 300 silt observation posts.

It has found that the sediment yield for rivers is not so much a function of runoff as of the geology of the catchment areas. Rivers in the Himalayan region carry far more sediment than the non-Himalayan ones. Reduction or prevention of soil erosion will greatly relieve the hazards of silting of rivers beds and of reservoirs. For rivers heavy-silt laden extensive soil conservation is the only fundamental solution.

The following suggestions are necessary for Soil Conservation Work in India :

Small watershed areas should be chosen on the basis of relative priority and provided with comprehensive treatment within five years.

Planning should proceed from the catchment or sub-catchment to the watershed or sub-watershed and programme implementation vice versa.

The package of conservation treatments of different physical and climatic regions should be developed and their design specification standardised.

Table 28·1

Sediment Data of Various Reservoirs

Reservoirs	Annual average silting rate acre ft.	Annual silting rate in acre ft. per 100 sq. miles		Total Sediment deposited in acre feet	Upto	Net Catment area in sq. miles	Capacity in Million acre ft.	
		Assumed	Observed				Gross	Dead
Hirakund	23,958	53·00	75·07	359,363	1971	31,912	0·320	0·06
Maithon	5,531	34·00	275 00	88,500	1971	2,010	1· 00	0·0167
Panchet	7,900	52·00	210·00	142,600	1974	3,790	1·214	0·148
Tungabhadra	13,740	90·00	137·00	261,261	1972	9,974	3·055	0·053
Ramganga	4,421	90·00	382·00	61,898	197	1,157	1·780	0 206
Nizamsagar	9,840	6 00	137·50	353,890	1967	7,152	0·682	0 094

To speed up soil and water conservation programmes higher financial support is necessary.

CONSERVATION OF WATER RESOURCES

The supply of water is also apparently inexhaustible but its availability is another matter. When forests are cut and vegetation destroyed, the land will not hold moisture. In dry seasons the water table (the level of underground water) drops, rivers dry up, lakes shrink, and wider areas of vegetation die, aggravating the situation. When rain finally comes, the water, unimpeded by the bare land, races across the countryside in flood. This alternate shortage and excess of water is partially solved by the construction of dams, some of which not only check floods but also retain water for irrigation, drinking and hydroelectric power. The growth of forests and vegetation, particularly on upland slopes, is another vital means of maintaining the water supply.

Scientists all over the world have repeatedly pointed out that, at the present rate of population and industrial growth, the world will soon be short of fresh drinking water. There is also a shortage of water in certain desert areas and semi-arid regions, while in Alpine and Tundra regions have huge reserves. Such observations under natural conditions are vital elements in dealing with many theoretical and practical problems, and in such practical applications are tapping ground water, extracting minerals, irrigation, drainage and hydraulic works.

Special importance is attached to ground water in relation to economic development which, incidentally, has seriously altered the natural environment in recent years.

CONSERVATION OF FORESTS

Development of forest resources is an integral part of the programme for optimum land utilization Forests have important protective as well as productive functions. They not only supply timber, fuel, fodder and a variety of other products but also have a moderating influence against floods and erosion and help maintain soil fertility. A number of industries, such as, construction, furniture, paper, rayon, plywood, matches, resin and tanning depend on forests for supply of raw materials. Development of forestry and forest industries is also essential for raising the income of the people who soly depends on forest areas of the world. Although the area under forest in various countries with few exception, continue to be at a low level, but the demand for various forest products, both for industrial use and for domestic purposes, has been steadily increasing. It is estimated that the requirements of industrial wood (including pulp material) which amount to 1035 million metric tons at present, would increase to about 3150 million metric tons in 1980. The demand for paper and rayon grade pulp, in particular, is likely expand considerably with growing population, increasing literacy and rising standards of living. As new plantations in humid and Taiga to take 25 to 30 years to develop, in the

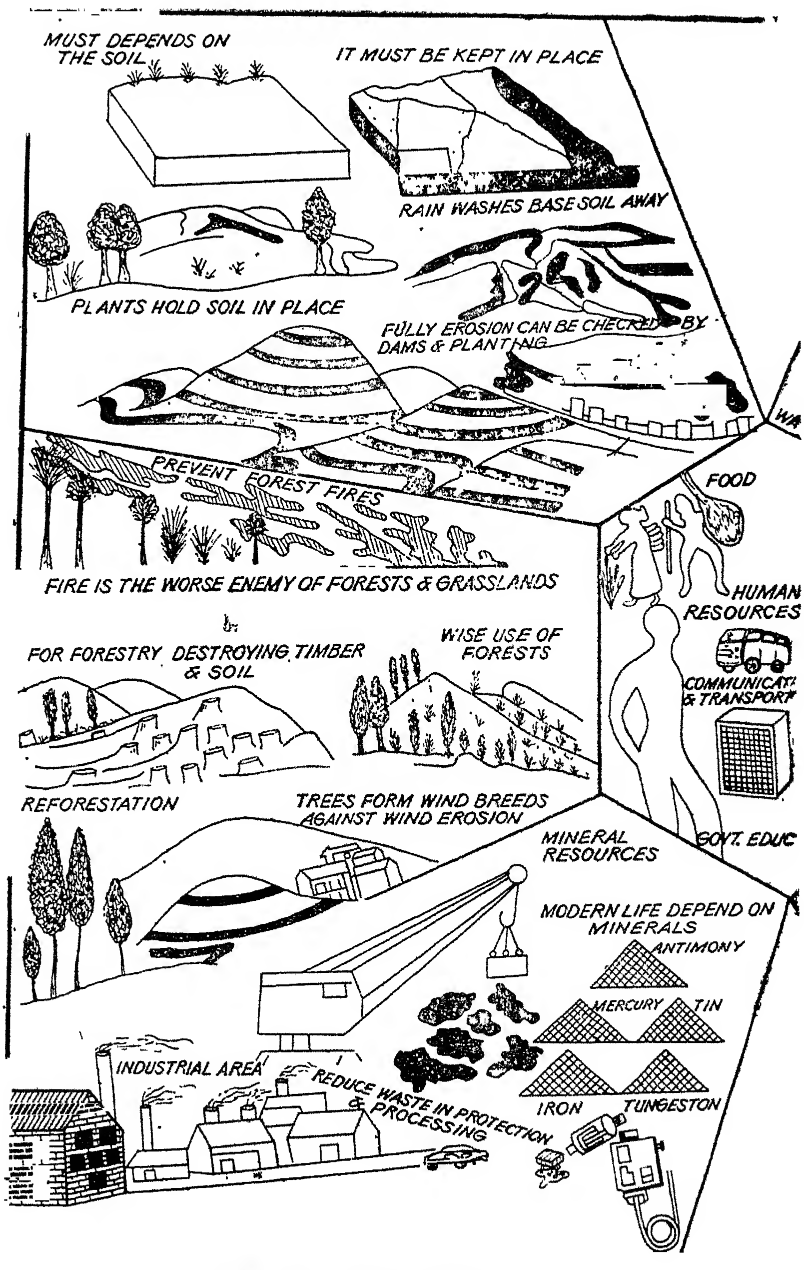
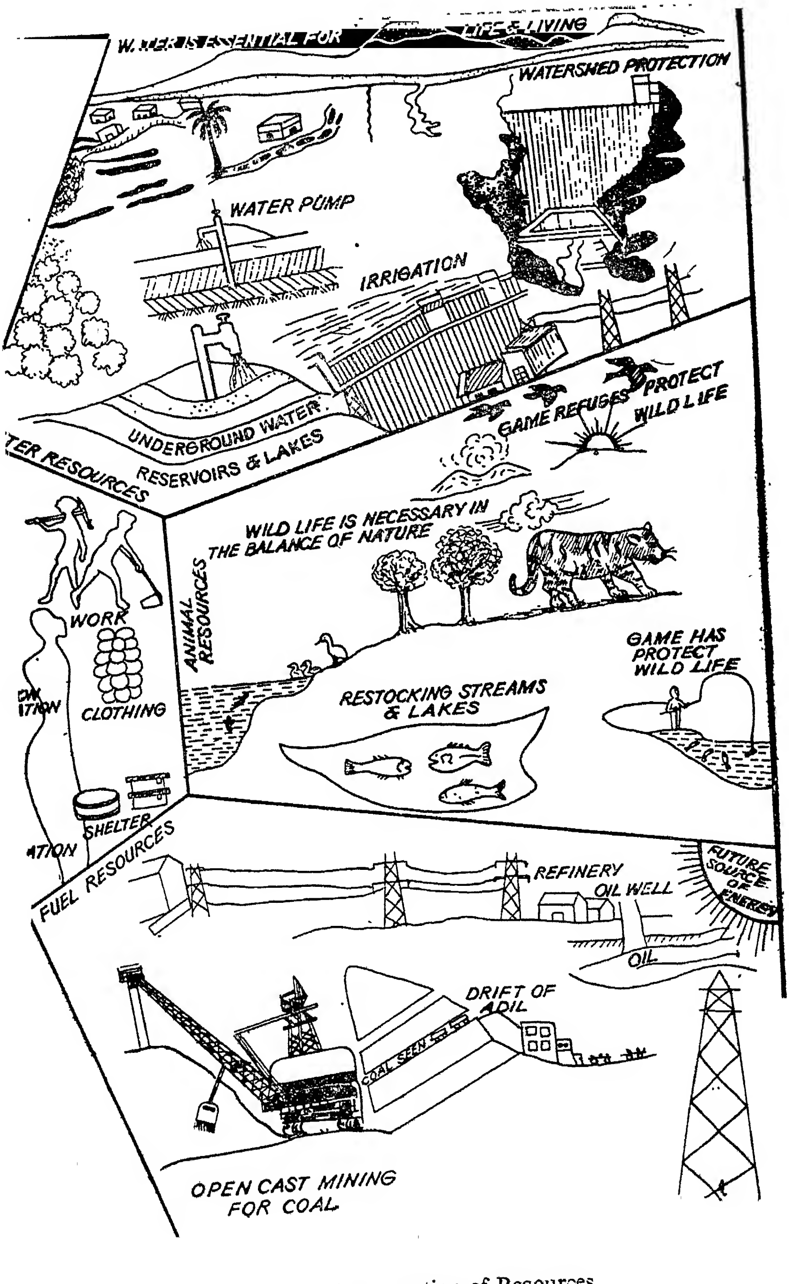


Fig. 28·8. Various methods of



Conservation of Resources

ordinary course production may not increase beyond 1500 million metric tons by 1976, thus leaving a gap of as much as 1650 million metric tons. In case of only one particular country as India, due to acute shortage of fuel wood, nearly 400 million tons of cowdung (wet weight) equivalent to 600 million tons of fire-wood is annually burnt instead of being put in land as manure.

Destruction of forests damages all natural resources. Forests hold ground water, slow its flow to the sea, provide covering for animal life, and generally serve as a protection for water and soil. By preventing forest fires, replanting, selective logging, more efficient use of logged wood, substitution of synthetic products wherever possible, the forests are maintained and continue to do their valuable work. Correct use of farmland helps to maintain and replenish the nutritional value of the soil and provides a protective covering against wind and rain erosion. National grasslands are also important.

CONSERVATION OF ANIMAL RESOURCES

Man, in his struggle for survival in an attempt to improve his living standards and comfort, has often been responsible for widespread destruction resulting in the complete elimination of forests, vegetation and certain animals. Man's fight for his own survival is often irrational and his greed results in destruction beyond his needs.

The destruction of animal life, including sea creatures, without provision for maintaining their numbers, strips man of the direct value of such animals and has other ill effects, such as reducing the fertility of soil dependent for nutritional replanishment on the dead bodies and excrement of animals. Closed season, hunting quotas and protected areas give animals opportunity to increase, if numbers become too great, hunting privileges are extended until a ecological balance is reached.

Unplanned intensive agriculture, rural and urban expansion, senseless cutting down of trees and clearing of bushes have deprived many species of birds and mammals of safe nesting and resting places.

During own childhood, it was not uncommon to see many species of birds, neelgais, foxes, jackals, deers, baboon, stag, Panther, Peacock and others within the boundary of cultivated fields. Shooting of various migratory and non-migratory birds used to be a regular weekend pastime. It was always very exciting to examine nests of weaver-birds and marvel at the genetic transmission of instinctive skill. Elders used to boast about the hunting of deers, cheetals and even Panther in this area. Today may daughter has to see these species in books.

Herds of majestic lions and tigers were slaughered for the ego and vanity of the rich. The fabulous elephants have been reduced in numbers by poachers, the old kings, and ivory hunters. The skin of romantically beautiful deers and *cheetals* make warm and

cosy rugs for meditators. *Neelgais* and other antlers have been completely exterminated from various areas by greedy hunters looking for meat and skin. A variety of Himalayan mammals are continuously hunted for fashionable rich women showing off their vanity through the soft and fleecy furs of helpless animals. Populations of hundreds of other species are seriously threatened in many areas by the unplanned rural expansion of unlimited ecological consequences.

From time to time, government and other agencies especially wild life and forest authorities have taken certain steps or conservation measures such as creation of wild life sanctuaries and ban on the hunting of some species. Such efforts are too little and too late, and remedial rather than preventive in nature. There is apparently little or no policy to conserve wild life in a coordinated way at national as well as local community levels so that maximum ecological and aesthetic advantages could be derived by our populace. Ban on hunting is an essential measure provided it is enforced at the right time and applies to predators and preys alike. Non-availability of food and shelter can reduce fecundity of animals.

Creation of few sanctuaries is essential for the re-establishment of the endangered species and thriving of the others; a healthy balance of nature should also exist within the ecological influence of the parks. However, the benefits of such sanctuaries can not be derived by our usually far off communities unless we establish chains of smaller wild-life refuges throughout the country. This is particularly essential in the plains which have no uncultivable hills and where every piece of land is under the plough.

CONSERVATION OF MINERAL RESOURCES

Because they cannot be replaced by man, minerals are a special problem in conservation. Wasteful mining and refining methods exhaust mineral deposits rapidly. To get maximum value with minimum depletion of mineral resources, more efficient systems of extraction are employed, refining is more thorough, new uses are developed, old minerals are reused, more by products are derived, and synthetics or other substitutes are used.

The following measures have been taken for conserving the limited reserves of coking coal in India.

1. Stowing

Stowing as a measure of conservation will need to be intensified during the Third Plan period since a part of the additional production is to come from existing mines by depillaring operations. While the larger collieries have their own arrangements for gathering sand and transporting it, for technical and financial reasons the smaller collieries are not able to establish these facilities. With a view to removing this handicap and to increasing the supplies of sand for stowing purpose, the Coal Board will establish severe

ropeways, four in the Jharia coalfield and three in the Raniganj coalfield. Sand will be gathered from the Damodar and Ajai rivers and transported to points within convenient reach of groups of collieries which have been selected with due regard to the urgency of stowing operations, the quality of coal, etc.

2. Establishment of Washeries

Washing being one of the measures of conservation, the second five Year Plan provided for additional washing capacity of 6·4 million tons to be achieved by the establishment of four central washeries and the installation of a washing unit as an adjunct to the Durgapur Steel Plant. The other three was completed during the early years of the Third Plan.

3. Restriction of output

Ceiling limits were fixed for the production of coking coal, the idea being to reduce output of coking coal to the level of the demand of essential consumers. However, during the Second Plan, owing to the need to increase production to meet the demands of the steel expansion programme, the limits were gradually raised again and now, with the commissioning of the new steel plants and the expansion of the existing ones, the reasons for pegging production have ceased to exist.

4. Other measures

Collieries which in the national interest are required to continue in production but which are handicapped by various adverse factors such as gasiness, depth of the workings etc. are given a special subsidy.

As mineral resources form the basis of modern industry in peace and in war, it is necessary to have a rational policy as regards their working and utilization. The keynote of this policy should be conservation and economic working. The essentials of such a policy of coordinated, orderly and economic development of the mineral resources are idicated in the following description. Though a mining industry has been in existence in developing countries for about half a century, only a comparatively small number of mines are being worked in an efficient manner under proper technical guidance. May units are too small in size or too poorly financed for such working. La k of a conservation policy is also responsible for the present condition of the industry. There is large wastage, especially in minerals of marginal grades, as these are either abandoned in the mines or thrown away on the dumps. Ways and means must be devised for the mining and recovery of these low grade materials. Ores which it is not possible to work economically under normal conditions should be left in the mines so that they may be extracted at a later date without serious loss. The mine dumps all over the country have to be carefully examined and sampled so that their valuable mineral content may be recovered by methods of benefication now not be undertaken and

that all grades should be worked and, wherever possible, blended to porduce marketable grades.

To bring about a general improvement in methods of mining as well as in the recovery of economically workable resources, mining interests will have to employ properly qualified technical personal for conducting mining operations.

The Indian Bureau of Mines should assist in this direction through its inspectorate whose function will be to inspect every mining operation and advice the owner on proper methods of development and also be responsible for the collection of detailed information on the nature of mining operations carried on, the mechanical equipment in use, and of development programmes proposed by each unit.

The world war II showed that valuable time and effort of various countries were wasted in conducting emergency exploratory work to develop resources of strategic minerals uneconomic to work in peace times and about the occurrences of which little information was available. The war also showed how difficult it was for the various governments to resist pressure to investigate every potential source of supply, however, small. It is therefore necessary that particular attention should be paid to strategic minerals such as sulphur, ores of tungsten, tin, vanadium, thorium, Uranium, etc., and the necessary preliminary information should be obtained so that production can be organized when required with the minimum of delay.

CONSERVATION OF ENERGY

Electrical energy appears to take part in nearly every change in industrial and economic life of the people. As heat is transmitted from matter of a high temperature to matter at a low temperature, so electricity passes from matter at a high electric potential to matter at a lower potential. This passes of electricity is called an electric current. Energy is nothing but a power or a force. We know that if a machine could run without resistance it would go on for ever at the same rate in virtue of inertia if energy is once imparted to it. But if a machine could not only keep going but set looms in motion as well, energy must be created at every turn, and experience proves that this has never taken place. If energy be a real thing the perpetual motion is impossible. Energy is always undergoing transformation, visible motion, magnetism, electrical power, heat, and light being some of the many forms which it assumes. But nature says sternly and unmistakably. Nothing for Nothing. No form of energy can be obtained without paying an exact equivalent in some other form.

Nothing appears more readily produced or destroyed than motion, heat or light. Motion is destroyed in a railway train by applying the brake, in a bullet by contact with the target. Heat can be destroyed by using it up in a steam-engine ; the visible

motion of fan over your head can be destroyed in turning a switch on board ; electric power can be destroyed in an incandescent lamp ; light can be destroyed by allowing it to fall on a black surface. Hence none of these things is real in itself. But when motion is stopped in a train heat is invariably produced, the wheels sometimes becoming red-hot. When heat is destroyed in a steam-engine, visible motion is produced ; when motion is destroyed in a dynamo—electric machine, electric power is produced ; when electric power is destroyed in a lamp, light is produced : and when light is destroyed by falling on a black surface, heat is produced. More than this, the amount of heat, motion, electric power, light, produced is the precise equivalent of wheat is destroyed in making it. All are capable of doing work of some kind,

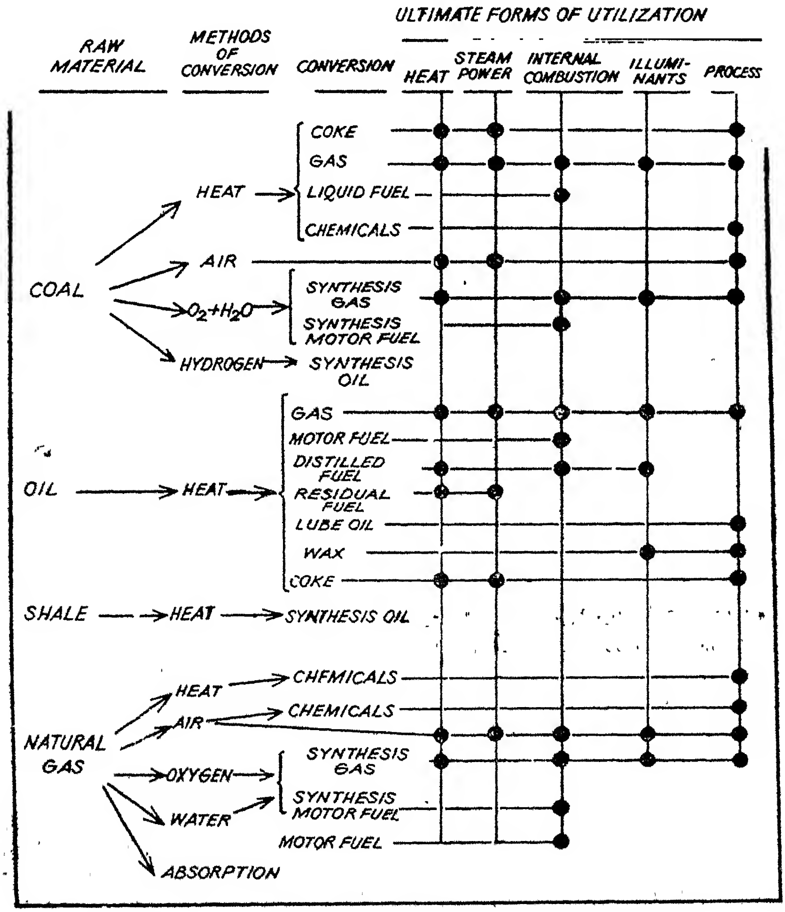


Fig. 28 9. Various forms of utilization of energy resources

and this power of doing work can neither be created nor destroyed its amount can neither be increased nor diminished. Energy is the name given to this real thing. Fig. 28·9 shows the various forms of energy and their utilization etc.

Scientists had found that energy can be changed from one form into another but it can neither be created not destroyed i.e. energy is conserved. This is known as the *Law of conservation of energy*. This state that energy can neither be created nor destroyed, but only transformed.

CONSERVATION OF HUMAN RESOURCES

Human beings are our most valuable resource. Childern can be regarded as sort of a crop, with the harvest beginning when the children become fulltime workers. Childern are the property of the nation. If is easy to see that the cost of raising this human crop is tremendous.

If we are conserve over human resources, we must provide medical services, educational facilities, safty and protection, vocational and recreation guidance, good living and working conditions and security for old age. By providing these items, we will insure the maximum physical, spiritual, emotional, intellectual and creative development of every person.

MODERN CONSERVATION

There are two modern popular conservation techniques. They are "multiple use" and "priority of use." The latter involves an analysis of a resource to be sure that it is put to the most efficient use in the light of needs and potentialities. The former involves the use of the same resources for a number of things, rather than concentrating on just one use or product : reservoirs provide flood control, irrigation, drinking water, hydroelectric power, and recreation ; farm lands provide two or more crops and forage land simultaneously or successively.

The success of any conservation programme depends as much on the public as on technical methods. Therefore, a continual educational campaign stressing the need for cooperation by everyone is a necessity.

Conservation programmes are conducted internationally (treaties on fishing rights) ; on a Federal or Central level (TAV and DVC, flood control systems, national parks, research agencies etc.) ; on a state level (forests, state parks etc.) ; and on an individual, private or local level (books, endowments, soil associations).

Conservation technicians work in such fields are forestry, wildlife management, soil conservation and agricultural practices ; the value of their work is widely recognized.

CHAPTER 29

MAJOR INDUSTRIAL REGIONS

Why Industrialization ?

The burden on land has reached its limits. Unless and until we create alternative sources of employment, it will not be possible to withdraw a portion of population from land. In view of this, if in the interim stage we aim at improving their standard of living : the remedly lies in providing additional opportunities for supplementary occupation. It is true that many nations which have attained a sufficient degree of industrial development can get an appreciable amount of relief, through international trade, from the economic defficulties which may result from a high density of population in relation to certain resources, raw materials, and kinds of capital equipment the domestic supply of which is inadequate. In this manner domestic shortages have been partly made up in Japan and almost wholly made up in Great Britain in the past. Samuelson put the matter in this way, "So long as raw material can be carried to the United Kingdom by relatively cheap ocean transport, the law of diminishing returns is largely robbed of any peculiar immediate local effects. The question arises : what can English industrial workers do for themselves in the remote parts of the Empire that they cannot do in England ? What can they do for the present generation of Australians and Canadians after migration that they cannot do in England.?"[1]

The possibilities of solving demographic and economic problems in this way are subject, however, to some limitations. Those countries which have succeeded in the past in supporting a very dense population at a high level of living by trading manufactured products for food and raw materials may find it increasing difficult to do so in the future. The industrialization of countries which up to the present, have had relatively little manufacturing activity may endanger the food and raw material supplies of the European idnustrial nations. Partly for this reason, those writers who look upon foreign trade as a means of alleviating the pressure of population upon resources in resource—poor industrialized countries, usually view trade as inadequate unless supplemented by emigration. However, there are also several factors that effectively reduce the importance of emigration in alleviating economic difficulties.

1. Samuelson, International Trade and the equalisation of factor prices, 1948, p. 183.

Industrialization is the barometer of the industrial development of any society or nation. Industrialization increases employment in the country all round. Labourers get more work, railways and transport agencies handle more goods, and the government gets more revenue from taxation. For the effect of industrialization is to increase incomes generally.

Industrialization provides on alternative source of employment to the people such as in Western Europe and North East North America where more than 40% people ingaged in industrial pursuits as shown in Fig. 29·1. In each of these two major industrial regions various geographical and socio-economic factors are responsible for the establishment of various industries in these areas. Besides these major concentrations several smaller and decentralized centres may be found in the Soviet Union, especially in the European portion, India, China and in Japan, sometimes called the Britain of the orient, largely in Southern Honshu and in Kyushu.

Industrial Regions

Industrial regions are those regions which are concerned with the economic activities of mankind. The smoke emitting chimnies far from the running train look like the volcanoes. They are sometimes spread over several hundred hectares of land. They continue to make specific and diversified production and their boundaries vary according to the availability of resources rather than physical region. In many countries of the world there are many important centres of industry, heavy and light, several other areas where modern mining or manufacturing is under way.

There are certain areas which show, owing to the concentration of certain manufacturing industries, all the characteristics of industrial regions. These characteristics may be said to be :

1. Large population engaged in industrial purusuits,
2. Large industrial complex in hierarchical order,
3. Integration of some main industry around which a group of number of subsidiary industries,
4. Large banking and credit facilities,
5. A network of communication lines ; and,
6. A large market for labour supply etc.

Bearing these facts in mind, it cannot be said that every town or centre where some sort of manufacturing is done should be described as an industrial region. This term should be reserved only for those areas which possess all the characteristics tisted above. The underlying idea is that in an industrial region a particular industry and the occupations depending directly upon it from the major source of the income of the people there. This criterion naturally leaves out from our discussion a large number of isolated places in every countries of the world where manufacturing industries, depending upon some local geographical advantages are car-

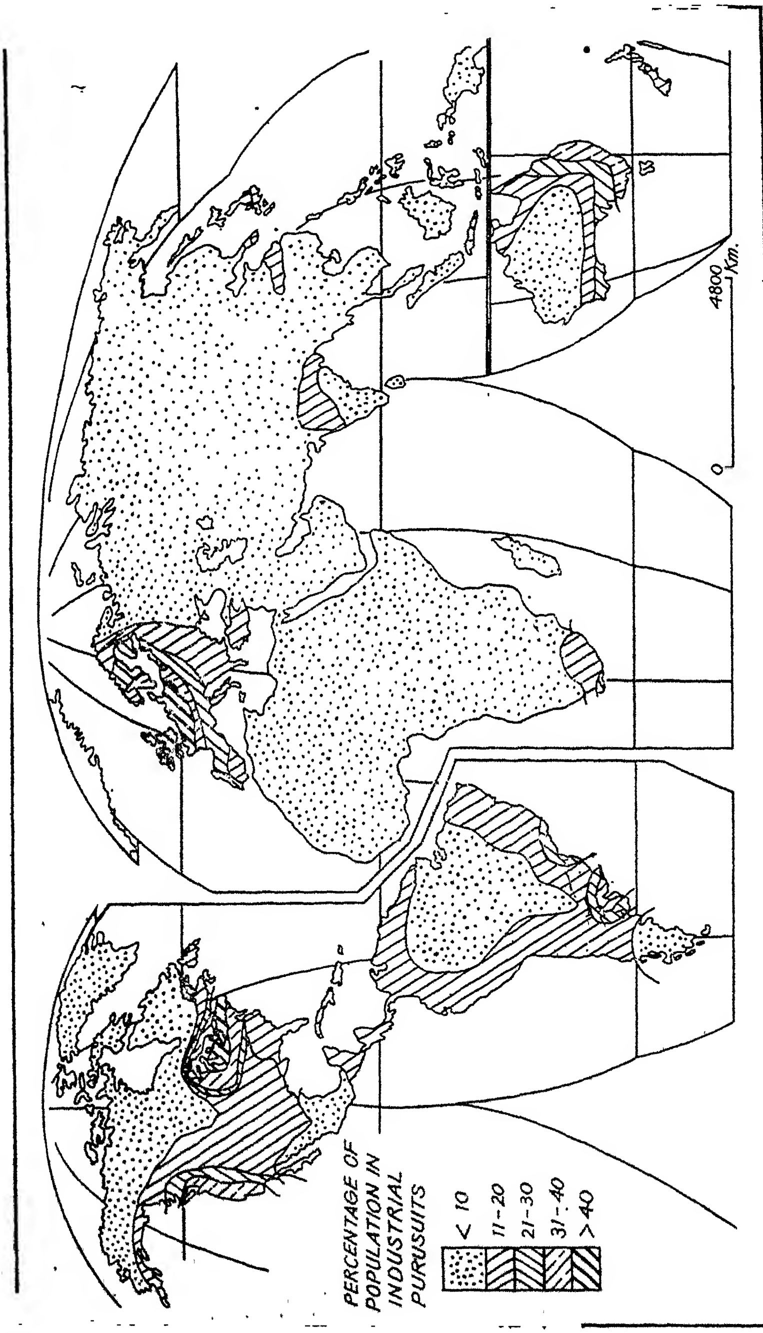


Fig. 29·1. Percentage of population engaged in industrial purusuits.

ried on. Such, for example are the places where a solitary cotton ginning factory or oil refinery or solitary cotton or sugar mill may be working or where there may be a small glass factory or a cement or lime factory.

MAJOR INDUSTRIAL REGIONS

The industrial regions of the world are very unevenly distributed over the face of the earth. Both natural and cultural factors are involved in any explanation of the distribution of manufacturing regions of the world, but the great differentiations in localization of any industrial region can be explained to a large degree by the availability of resources. Since the development of machinery, many industrial centres have sprung up where there is abundance of coal, or coal and iron, or extensive water power, the mainsprings of modern industry ; and all such towns are more or less business centres Yet they are often far from being business centres in proportion to the extent of their production. Where numerous manufacturing towns exist on a great coalfied the business of exchange may be centred in one of them that is not pre-eminently itself a manufacturing town. The great magnitude of the business of exchange in such a region is adverse to the carrying on of manufactures in its business centre, for the cost of land, owing to the requirements of merchants and others for offices etc. becomes so great that it is too expansive to great large factories. Hence it is that Bombay, in which, according to the estimate of a local manufacturer, is sold probably three-fourths of the cotton-yarn spun, and even a larger proportion of the cotton cloth woven in the Indian Republic, is less of a manufacturing town than many of the smaller towns round about.

What has just been said makes it clear that a variety of influences must be kept in mind as affecting the localization of industry. These work in combination, in some cases one or two of them having the chief efficacy, in others another group, and unfortunately neither individually nor in association is it possible to measure them. The main localizing influences may be considered under the heads of the market, the labour supply, the cost of land resources, the situation of raw material, the nature and situation of the natural and human resources, the value of the commodities produced in relation to the cost of the various items entering into their production, and finally the supply of capital.

It is obvious that the profitableness of large scale operations must depend on the adequacy of the market, which again is governed by various conditions as :

(1) The number of people where the industry is carried on;

(2) The purchasing power of the people, a great contrast in this respect being presented by developing countries as compared with developed countries and other semi-developed countries, in which latter the purchasing power is enhanced by the diffusion of

education, and probably still more by the extent of the available undeveloped resources ;

(3) The nature of the commodity for which a market is sought-cheap goods for peoples of small purchasing power, more valuable commodities for regions in which individual wealth is greater ;

(4) Facilities for transport as enlarging the range of the market. Here it may be noted that the aim of protective or preferential tariff is to preserve a large market for the favoured industry or industries where the protection afforded is absolute, the whole country embraced by the tariff forms a local market for the protected industry.

INDUSTRIAL REGIONS OF JAPAN

Japan is known the "Britain of Asia" and is the most highly industrialized nation of the East. Japan was famous for its hand made goods. It old-time craftman excellent in strangely artistic silk goods, in lacquered trays, and quaint pictures of wonderfully blended colours. Its pottery was very pretty and delicate. There are good supplies of China clay or Kaolin, weathered during long centuries from the hard old granite mountains of the north. Fine porcelain is still made.

Modern factories have now taken place of the old time hand workers. The still cocoons are unwound by machinery. The home-grown cotton is manufactured by the most modern methods and much raw cotton for manufacture is imported from China, U.S.A and India. Despite its shortage of industrial raw material and solid fuel, it has been able to develop industries at an astonishing rate. Thus Japan is a keen competitor for the trade in the East. In 1930, less than 20 percent of Japn's population was engaged in manufacturing industries, but today this has risen to more than 65 percent. Japan was once a major importer of all manufactured goods, but now-a-days, more than 90 percent of exports are made up of manufactured products. Most of the industrial development of Japan has taken place since the world war II, and Japan's industrial structure underwent some remarkable changes.

The first feature of industrial development of Japan was the changing composition of industry, which emphasis upon greater diversification of manufacturing.

The second respect in which the Japanese industrial structure changed since world war II was in the technical efficiency of factory industries. Factory managers learned to make more efficient use of labour, power and materials and improved equipment and manufacturing processes were introduced. The results were increased output and lower production costs.

A third and most significant feature of Japans industrial change since world war II was the increasing invention and control of state

over industry. The iron and steel, petroleum refinery and ship building industries were brought under strict control of the Government.

Japan's industrial equipment 1970 numbered 652,900 plants of all sizes, employing 11·2 m. production workers. Since world war I there has been a shift from light to heavy industries. The production of electrical applicances and electronic machinery has made great strides : television sets (1972 : 13m.), radio sets (1973 : 26·8 m.), cameras (1972 ; 5·3 m), computing machines, automation equipment are produced in increasing quantities. The chemical industry ranks third in production value after textile and iron and steel. Production, 1971, included (in metric tons) : Ammonium sulphate, 2 m., calcium superphosphate, 708,000; sulphuric acid, 6·7 m; caustic soda, 2·8 m.

Japan's textile industry before the war had 13 m. cotton yarn spindles. After the war she resumed with 2·78 m. spindles; in 1964 8·42 m. spindles were operating. Output of cotton yarn 1971, 534,000 metric tons and of cotton cloth, 2482 m. sq. metres. Since 1955 Japan has lead the world in shipbuilding and now accounts for 50% of the world's launchings. In 1970, 10·1 m. gross tons were launched, of which 6 2 m. were exported. In 1972-73 the world's largest oil tanker, the *Globtik Tokyo* (477,000 DWT) was launched from Japanese shipyard.

The manufacturing region of Japan is concentrated largely in a thin belt nearly 960 kilometre long which extended from the Kwanto region on the north east, along the Pacific coast to the Nagoya area and thence through the Kinki area and along the shores of the Inland sea, to Nagasaki in northwestern Kyushu. There are four major industrial regions of Japan as shown in Fig 29·2.

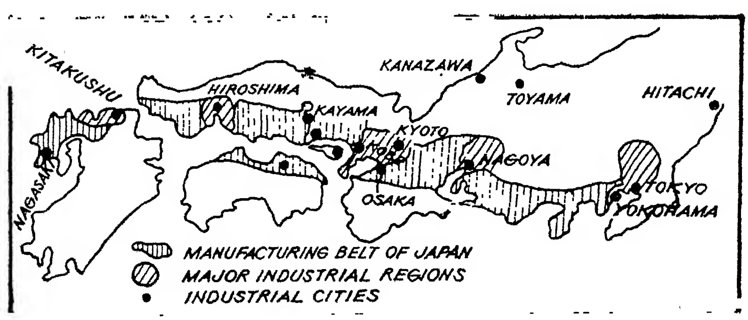


Fig. 29·2. Industrial Regions of Japan.

THE KEIHIN REGION

The greatest industrial region of Japan is the Kwanto plain and is formed by the conurbation of three chief cities,Tokyo, Kwasaki and Yokohama. In 1973 the former had a population of nearly

of over 8,583,000 and the later over 2,377,000 while Kawasaki 960,000 only. Tokyo the capital of the country, is favourably situated in the middle of a small fertile plain known as Kwanto plain, and carries on many artistic industries. Tokyo is noted for electrical engineering such as transistors, radios, television sets, washing machines, refrigerators and computers. Today it ranks high in blast furnaces, steel mills, machines and tools, chemicals, oil refineries, shipbuilding, airplane factories, electrical machinery and textile. Itis estimated that 10-15% of the nations pig iron, and 11 to 12% of its steel originate in this centre.

Kawasaki is the second industrial city of this region, Kawasaki, a industrial city of 960,000 in 1973. Primarily it is a centre of heavy industries with blast furnaces and iron-steel mills, oil refineries, chemical, cement plants, great shipbuilding yards, and the like.

The coastal industrial district of Tokyo in Shinagawa, Ebara, Omari and Kamata wards is continued southward along the coast toward Yokohama is a continuous industrial centre. Throughout most of its history Yokohama has been chiefly apart city and manufacturing has been overshadowed by trade. One reason for the slower development of industry has been restricted area of level land suitable for the expansion of factory sites. Yokohama has precision engineering, ship building, oil refining, petro-chemicals and port industries. A northward expansions of Yokohama boundaries after World War II brought this industrial area, including the principal Tsurumi centre, within the city limits. Large areas of newly reclaimed land along, the coast of Tokyo Bay provide desirable sites for a considerable number of large and modern factories. The large size of the factories in this area give it a typically industrial appearance. Great shipbuilding yards, cements, breweries, petroleum refineries, blast furnaces and steel mills, engineering works and chemical plants are representative of the types of industry to be found in this newer manufacturing area on the northern margins of the city.

THE KINKI INDUSTRIAL REGION

The Kinki or Hanshin industrial centre is confined at the eastern end of the Inland Sea at the head of Osaka Bay. In the Hanshin region are three of the Japan's six great cities—Osaka, Kobe and Kyoto, the first two of which are also among the three great deepwater parts. In addition there are ten or twelve smaller cities, four of which have populations between 150,000 and 300,000 and three between 50,000 to 150,000.

The manufacturing structure of the Hanshin region is one of the great diversity. Until recently at least, textiles lead all other industries. The cotton industry is carried on chiefly at Osaka and other towns in the fertile plain that borders the northern shore of the inland sea. Osaka is the greatest cotton-textiles town and is generally known the Manchester of Japan. Here the naturally dense population makes labour cheap, and affords a good market. As Osaka has but a poor harbour, it is largely served by the port

of Kobe. The Osaka Kobe industrial region is as smoky, noisy and unattractive in appearance as are most regions of heavy industry. Kobe concentrates on ship building, oil refining, and petrochemical industries including synthetic textile and rubber manufacture. To the north of Osaka lies Kyoto, the old capital of Japan, where stand the palace of former Mikados and numerous Buddhist temples. Kyoto concentrates on traditional handicrafts, toy and lacquer works and therefore free, until recent years at least, from the grime and noise of a typical factory landscapes. All the towns along the coastal belt of the Inland Sea are connected by a railway, which runs northward to Tokyo and Yokohama.

THE ISE BAY REGION

The third industrial region of Japan is known the Ise Bay region which is dominated by one large town Nagoya. Nagoya, a industrial city of 2051,000 in 1973, has grown with extraordinary rapidity during world war II. This Ise Bay industrial region accounts for about 10 to 12 percent of the nations factory production. Located as it is an one of the Japan's larger plains, there is ample room for urban and industrial establishments. Nagoya has Textile mills that process local silk, imported cotton and wool and also synthetic fibres; engineering industries, including all kinds of machinery, automobiles, locomotives and aircraft. Textile, including silk reeling, cotton spinning, cotton weaving, and wool weaving led all other industries. Much of Nagoya's woolen industry is relatively new and Australian Wool is chiefly used. Nagoya is one of the countrys foremost aircraft manufacturing centres.

THE KITAKYUSHU REGION

This industrial region is located close to the South Western limit of the general manufacturing belt in Northern Kyushu. It ranks fourth among the manufacturing concentrations, being credited with nearly 9% of the nation's industrial output. Chikuho coal field situated close proximity of this heavy industrial centre. Textiles are not an important element of the industrial structure of this region of first importance are the heavy industries, especially iron and steel manufacturing. About a third of the pig iron and 40 to 50 percent of the steel manufactured in Japan proper is produced in Kitakyushu or North Kyushu industrial region. It is the chief steel supply centre for other industrial regions of Japan. Northern Kyushu are a wide range of manufacturing industries including : cement factories, shipyards, flour mills, glass factories, chemical factories and engineering industries

Yawata, Kokura and Moji are other industrial centres of this region. This industrial region extends Southwards to Fukuoka and Nagasaki. Nagasaki, a city of 427,000 in 1973 is the excellent harbour and also builts ships.

It is the only one of the four *industrial* regions that has no great metropolis, the largest city having a population 1047,000. Fukuoka (879,000) is a small city in this industrial region.

Outside the above mentioned major industrial regions there are several scattered industrial cities such as Muroram is famous for iron and steel; oil refining is important at Akita and Niigata, engineering at Hiroshima, shipbuilding at Kure and textiles at Okayama.

INDUSTRIAL REGIONS OF CHINA[1]

Cottage industry is very old in the economy and persists into the 20th century. Modern industrial development began with the manufacture of cotton textiles, and the establishment of some silk filatures, steel plants, flour mills and match factories.

The Communist Government inaugurated its First Five Year Plan is 1953. The First Five Year Plan gave priority to the development of heavy industry as Mao Tzetung described the task as that of "Changing China from an agricultural state into an industrial country, because without industry there can be no solid national prosperity and power.[2]

The objectives of the First Five Year Plan appear to be four—

1. to concentrate the main strength on heavy industry, notably mining, steel, cement and chemicals,
2. to train personnel and to develop transport and light industry.
3. to form agricultural cooperatives and improve methods of agriculture,
4. to reform private industry and incorporate it into the State Plan.

Rapid industrial growth during the First Five Year Plan period was perhaps the most outstanding short term economic achievement of the new government. In the initial period of the great Leap forward, the high rate of industrial growth continued and reached a peak in 9:9, but thereafter it suffered a sharp decline. The objectives further indicate that "in our industrialization the machine building and electrical industries, ferrous and non-ferrous metallurgy, fuel (coal and oil), transportation and agricultural machinery industry will be given priorities just as they are in the U.S S.R."[3] Since the withdrawal of Soviet aid and the failure of the "Great Leap Forward" a more modest emphasis has been placed on it. Industrial policy during these recovery years emphasized the development of a small number of key industries rather than the overall expansion of the industrial base. This policy was also followed in the late 1960's. By the mid 1960's considerable stress was placed on the development or rural light industry which was a continuation of the policy of 1958.

At the end of 1966, work in factories was affected by the Cultural Revolution an 1967 industrial production showed a decline over the 1966 level. In 1968, the worst excesses of the previous years were dispelled and the downward trend reversed. The up-

1 Cressey, G.B.—Land of the 500 million, p p. 149–171.
2 Mao Tze-tung—on contradictions
3 L chen : How China will industrialize, Peoples China, No. 3, 1953.

ward trend continued in 1969 with a further rise of about 10%. Further growth of industry can be expected to be relatively slow. Nevertheless, in the context of Asia, China now stands as an industrial power of some consequence.

The main industrial regions are as follows :

LOWER YANGTZE INDUSTRIAL REGION

This is China's oldest industrial region because the area has been open to foreign influence since the mid of nineteenth century. Shanghai is the main industrial town and part of this industrial region. This is an areas for the production of consumer goods such as cotton, silk and textiles. The cotton textile mills of Shanghai industrial region are some of the largest in Asia. Shanghai and the Lower Yangtze delta area clearly lead in total industrial output. There are also shipyards, oil refineries, flour mills, steel plants, metal works and a great variety of light industrial products. There are many machine tool shops and electrical factory. Heavy industry has been limited to shipbuilding, the assembly of machinery and automobiles from overseas, and the processing of imported materials. There are many industrial cities such as to the south is Hangchow, well known for silk, to the west are Soochow, al o with silk, Wusch with flour mills. Many other centres of industry, old style and new, make the region from Nanking to Ningpo China's number-one workshop.

Shanghai stands at the mouth of a small tributary, which enters the estuary of the Yangtze on its south site It forms the port, not only of the basin of the Yangtze, but of much of the Great Plain, owing to the absence of other ports on the shares of the yellow sea. Shanghai, being the premier port of China, also handles the bulk of the foreign trade. The chief exports are silk, raw cotton, tea and wool.

SOUTHERN MANCHURIA REGION

Another great industrial region is formed by the three cities of Anshan—Fushun and Mukden The largest city of Manchuria is Mukden, called Shenyang in Chinese. Anshan Fushun and Mukden form a triangle, within which are numerous large plants. Here the Japanese developed the largest coal mine, by far the largest blast furnaces and almost the only important steel mills, major factories for railway equipment, cement plants, chemical works, military arsenals, and factories for the processing of agricultural products. The availability of both coal and iron ore is the basis of the iron and steel industry in this triangle The Anshan Iron and Steel works had a rated capacity of 1950,000 metric tons of pig iron and 800,0 0 metric tons of steel products a year. Anshan thus ranked among the dozen largest iron and steel centres in the world

TIENTSIN AND PEKING REGION

Third in importance may be the industrial complex centred on

Tientsin, and extending from Chinwangtao southward along the coast past Kaiping, Tangshan and Tangku, and thence westward beyond Peking. The presence of coal-fields in Shansi and Hopei has contributed to the rise of the metallurgical and engineering industries here.

Peking, the capital of country, stands a little north of the Pei-ho, and is the focus of many routes. The town is composed of two portions—a sequare enclosure to the north, which is the Manchu city, and a rectangular area to the south, which is the Chinese city. Both are surrounded by high, massive walls pierced by gates which are surmounted by towers. Within the Manchu city are the palaces of former Emperors and many magnificant temples. Peking has usually been regarded as a centre merely for native crafts, but its stell mills and new industries are giving it a modern industrial complex. Tientsin concentrates on ship building, textiles and chemicals etc.

RED BASIN REGION

During world war II Chungking in Red Basin was the capital of China. Therefore industry in the eastern coast were shifted to Chungking and near about the town where means of communications not so developed. The rice deposits of coal, iron, ferro-alloys and abundant agricultural raw materials have all encouraged industrial development. Many plants established here producing iron and steel, cotton textile, paper mills, cement, chemicals and machinery are made here.

SI-KIANG DELTA REGION

Southern most China is supplied by industrial production in Canton and Hongkong. Once known largely for commerce, it contains refugee industries which include a wide array of consumer products for both the Chinese and overseas trade. Canton lacks local raw materials, and is not a seaport, so that it has only a limited amount of modern industry such as textiles, chemicals, brewing, handicrafts and food processing cement works are important. Shipbuilding is also important. Fig. 29·3 shows the industrial regions of China.

WUHAN AREA

This industrial region is confined in Central Yangtze and Han Basin. There are three industrial cities namely Wuchang, Hanyang and Hankow. The iron and steel works here are based on Pinsiang coal and Tayeh Iron ore. Ship building, metallurgical and heavy industries railway equipment and chemicals are important items of production. Yangtze forms a magnificent waterways being navigable for large ocean vessels to Hankow, and for smaller sea vessels to Ichang—nearly 1600 km. from its mouth. The Yangtze has many large tributaries, but those of most commercial importance are the Han, which is a fine navigable river, and the

tributaries which cross the Sechwan basin and are useful for irrigation, as well as being navigable in their lower courses.

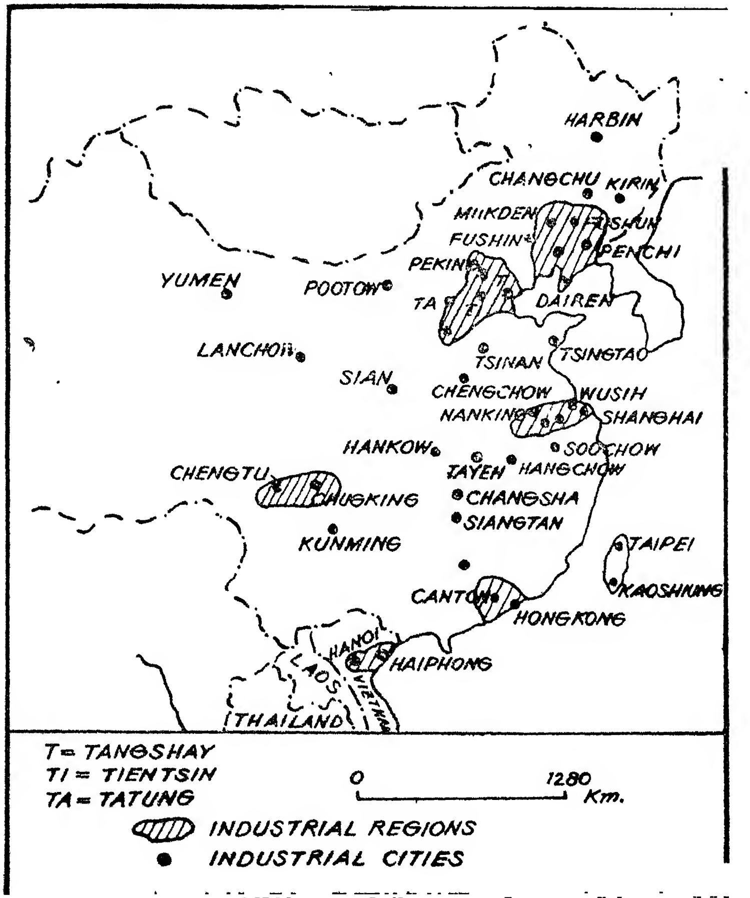


Fig. 29·3. Industrial Region of China.

TAIWAN REGION

There are two industrial cities one is in the north and second in the south. Taipei has a blast furnace, and Kaoshiung has oil refineries and metal works. Metal work, stone work, and other industries are carried on, but the place is mainly a great depot for collecting and exporting tea, cotton and sil k.

INDUSTRIAL REGIONS OF U.S.S.R.

The main branch of the U.S S.R. economy is industries. In 1972 is accounted for more than 50 percent of national income. The foundation of Soviet industry is public ownership of the means of production. Thanks to the advantages of the socialist system,

the U.S.S.R., in an historically short period of time, has done away with age long backwardness and in the volume of industrial production now holds first place in Europe and second in the world, next to the U.S.A.

The U.S.S.R. is at the top of the world's table in the output if iron ore, coke, coal, electric locomotives, tractors, harvesters, timber, cement, precast ferro—concrete structional element, pane glass, woollen and cotton fabrics, sugar and fish. Soviet share in the worlds industrial output is steadily growing. In 1917 it was less than 3 percent, in 1937 it increased to about 10%, and in 1972 the U.S.S.R. accounted for nearly 1/5 of the world's gross industrial output. It is only in the last half century, through the various five year plans, that the vast territory of Asiatic U.S S.R. has been gradually developed. Much development is still going on. More than 75% of Soviet industry is still confined in European Russia. There are six major industrial regions, which are described below and shown in fig. 29·4.

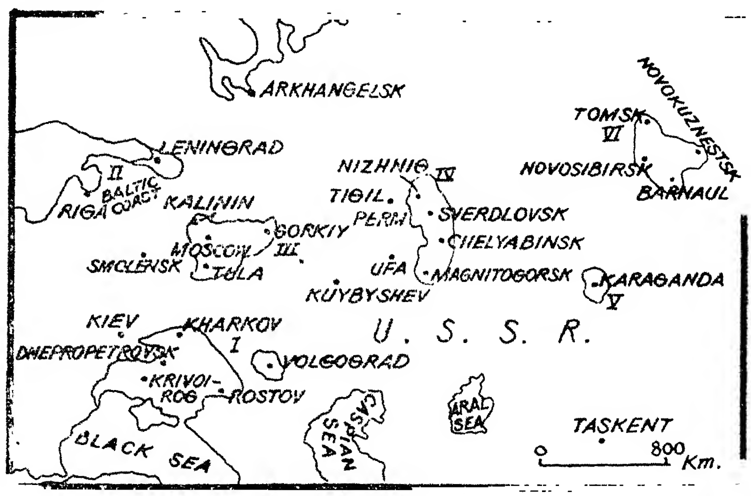


Fig. 29 4. Industrial Regions of the Soviet Union

THE MOSCOW-GORKI REGION

The oldest and the greatest of the Soviet industrial regions include such cities and towns as Moscow, Tula, Gorki, Yaroslavl and Ivanovo. Moscow is the centre of this industrial region and the capital of the R.S.F.S R. and of the whole U S.S R. It is the largest city in this industrial region and in the U.S.S.R. out of the 30 percent of the countrys total industrial output which fall to the industrial centre, more than 20 precent fall to the Moscow region, including 16 percent (i.e., more than half the total industrial output of the industrial central) to Moscow alone.

The principal branch of industry in Moscow is machine buld-

ing (manufacture of complex and precision machines which requires highly skilled labour) ; next come the food ; textile, swing, chemical industries, and the printing and publishing industry, for which Moscow holds first place in the Soviet Union. Machine building in Moscow and its environs is rather of a labour consuming than of a metal absorbing character. Many of the Moscow metal working and machine building plants enjoy a nation wide reputation.

The town of Gorki is one of the biggest ports on the Volga as regards traffi capacity. Taking a central position on the Volga, Gorky or Gorki is the organizational centre of the Volga navigation, an important railway junction and trans-shipping point, at the same time it is a very big industrial centre. Owing to its favourable location on the Volga between the industrial centre and the Urals, which makes it possible to deliver here a great variety of raw materials from all parts of the country, Gorky was selected as a site for the construction of the Molotov Automobile Plant—one of the biggest in the world. Gorki with its environs is also the most important centre of chemical industry, its chemical enterprises produce fertilizers for agriculture and chemical materials for various branches of industry.

Tula is the third important industrial city in this industrial region. Tula which is located in the centre of the Moscow coal basin, in the proximity of a number of iron ore deposits, is a big railway junction. It was an ancient centre of metal industry in the Moscow state. Under the influence of competition on the part of the Urals in the eighteenth century, local metallurgy was abandoned, but metal working was preserved. Under the various Five Year Plans metallurgical production, based on local ore deposit, has been restored large and greatly intensified. At the same time machine-building has been developed in Tula. Ivanovo is the centre of this industrial region. Ivanovo itself is noted for cotton, textiles, machines, chemicals and light industries.

THE UKRAINE INDUSTRIAL REGION

The Ukraine is particularly distinguished for its output of coal, iron ore, pig iron and steel. The Ukraine has become the biggest coal and metallurgical base of the U. S. S. R. and one of its most important sources of food supply.

Combining coal from the Donetz field with the iron ore from the mines in Krivoi Rog has made possible the development of a large ferrous metallurgical industry in the Ukraine. The Ukraine also contains oil, rich deposits of salt and various important chemicals. Oil output was 1 m. tons in 1913, 353,000 tons in 1940 and 14·3 m. tons in 197 , with 64 7 cu. metres of natural gas.

The Ukraine has highly developed chemical and machine construction industries producing one-fifth of the total output of machinery and chemicals in the Soviet Union. The large part of

the Ukraine chemical industry is engaged in the manufacture of fertilizers. Thus the development of chemical industry, just as the development of agricultural machine building, has strengthened the connections of heavy industry with agriculture. The chemical industry of the Ukraine is provided with all the conditions necessary for its development, namely :

1. there is a variety of raw materials in the shape of production waste of coal coking and metallurgy, of deposits of salt, phosphorite etc. ;
2. there are sources of power in the shape of coal and water ;
3. there is demand for chemicals on the part not only of industry, but also of agriculture. Chemical fertilizers which are particularly required for the cultivation of Sugarbeet.

The growth of all branches of the Ukrainian heavy industry—of coal-mining, metallurgy, machine-building and chemical production-requires enormous quantities of cheap and easily transportable energy. This energy is obtained from electric stations built under the five year plans and working on coal dust (waste of coal-mining) and on the hydro-power of the Dnieper rapids that is Dnieper Hydro-electric station The heavy industry of the Ukraine is generally concentrated in two big districts : in the *Donetz Basin* which includes the entire coal-mining, most of the thermal power stations, and the greater part of ferrous metallurgy and machine-building, and the *Dnieper area* which concentrates the entire mining of iron ore and of Nikopol manganese and a large part of metallurgy, machine building and chemical industry.

The region is also known as Donbas industrial region. The Donbas is a landscape of mines and factories set amid towns and workers settlements. The association between raw material and fuel resources of the Donbas region, the Dnepr bend, Krivoy Rog and Kerch has led to the development of a major iron and steel industry. Many large industrial cities have emerged at Donetsk, Dnepropetrovsk, Krivoi Rog, Rostov, which make iron and steel, chemical and machine tools.

THE URALS INDUSTRIAL REGION

This region has been developed as a industrial region after world war II. This region was a latecomer into the field of heavy industry, but once it established its reputation in the field of industrialization, Urals developed industrially at a rate that has been little short of phenomeal. The bulk of Soviet industry lies in the Ural. This region is particularly rich in iron ore, ferro-alloy metals, non ferous metals, and non-metallic minerals. The magnetite iron deposits of the eastern slope are richer than the sedimentary deposits of the west, but along the western foot are important petroleum and salts deposits. Unfortunately, there is a deficiency of good coals, particularly those suited to metallurgical coke, though the small deposits of both coal and lignite are used to generate electri-

city. Great quantities of coal for metallurgical use are received from the Kuzbass and Karaganda areas. The extensive production of metals, including high-grade and non-ferrous metals, has provided a base for the development of a powerful machine-building industry in the Urals, and, primarily, of heavy, metal absorbing machine building which manufactures equipment for the metallurgical industry itself, for transport and agriculture. The most important centres of machine-building in the Urals are Sverdlovsk, Chelyabinsk Nizhny Tagil, Nolotov and Ufa (or to be more precise, Chernikovsk near Ufa). The following machine-building plants are the biggest in the Urals :

1. the "*Uralmash*" in Sverdlovsk—a plant of heavy machine building for mining and metallurgical industry, a plant giving birth to new plants, with a production capacity sufficient to provide an annual supply of equipment for such big enterprises as the Magnitogorsk plant ;

2. The Nizhny-Tagil railway carriage building works based on the metal supplied by the Novotogil plant, and on local timber resources ;

3. The Chelyabinsk tractor plant manufacturing heavy tractors of the well-known "Chtz" trade mark.

The chemical industry was actually newly created in the Urals in the Soviet period, and there are rare combination of various chemical raw materials in the Urals, including deposits of potassium and common salts, phosphorites, chromites, pyrites, as well as the waste gases of coking of processing non-ferrous metal ores and of coal burning. The biggest new enterprises of the chemical industry are the Berezniki and Magnitogorsk chemical combines. Molotov concentrates machine building, ship building, wood working, oil refinering, paper and cellulose and fertilizers.

THE KUZBAS INDUSTRIAL REGION

The industrial towns of western Siberia lie mostly in the valley of the Tom, on the Kuzbas coalfield, but there are big industrial outliers at Novosibirsk, Barnaul, Tomsk and Novo Kuznetsk. The raw materials available locally are coal of coking quality and iron ore in the Gornaya Shoriya, and there are large reserves of timber. The region is a producer of coal and semi-finished iron and steel goods widely exported throughout Siberia and Soviet Central Asia, Novosibirsk and Kuzbas towns are important for engineering and a big tractor and farm machinery works operates at Rubtsovsk. The textile industry of Barnaul works raw cotton brought from central Asia, and Siberian timber is used for constructional purpose and extraction of resins and other substances. In Tomsk city saw milling, pulp and paper and light industries are important. Machine building, supply equipment to the Kuznetsk basin and the wood-working industry, has greatly developed here in recent years. The industries of this region are similar to those of the Urals.

BALTIC COAST REGION

Industry in Baltic coastal region has its main emphasis on manufacturing from imported raw materials from both within and without the U. S. S. R. It imports coal from the Donbas and Yorkuta and even from Poland, and uses local peat and oil shales to generate electricity, which also comes from hydro electric stations. Leningrad is the representative city of this industral region. Leningrad produces a wide range of machinery and transport equipment chemicals, textiles and consumer goods. Synthetic rubber from potato spirit was manufacture by the laboratory work at the Leningrad Krasny Treugolnik plant, this method was later adopted by synthetic rubber plants in other parts. Chief among. other industrial branches in Leningrad are the textile industry (manufacture of cloth, cotton fabrics, and especially of thread and knitted fabrics) and industries which are concomitant to big towns, namely, the fooo, sewing and printing and publishing industries.

KARAGANDA REGION

The region is based on the rich Karaganda coal and ironfield. It has all the important mineral resources required for large scale heavy industries and engineering works. There are many metal smelting works. The manufacture of tractors, automobiles and locomobiles is growing along with the output of hight industry.

Besides the large industrial regions, there are many scattered and small industrial regions. In Eastern Siberia, the Cheremkhovo -Irkutsk region uses local coal and salt or mineral imported from nearby producers, plus locally generated hydro electricity. It makes mostly heavy chemicals and engineering articles.

The Amur Ussuri region is also a producer of semi-finished goods, notably with concentration on wood by products. Vladivostok concentrates marine engincering, oil refining, iron steel fish canning and crabs etc.

Tashkent is the greatest textiles town. In Northern Caucasia and Transcaucasia are a wide range of manufacturing industries including ferro-alloy, non-ferrous metals and non-metallic minerals. Both regions have a large petroleum-refining capacity which until recently treated large quantities of crude petroleum from other fields iron and steel making, using local coal and ore, and ferro-alloy production have been developed in Georgia to provide metal for the Trans-caucasian pipe, tube and petroleum engineering industry.

INDUSTRIAL REGIONS OF EUROPE

The main industrial belt of Europe broadly coincides with the coal fields. From Britain the belt continues through northern France and Lorraine and the Sambre-Meuse valley of Belgium, into the Saar and the Rhine westphalian industrial complex, then along the edge of the Harz mountains and into Silesia, to reappear in the great industrial areas of the Eurasia.

The major industries of the countries of Europe, and in particular the iron and steel industry, have become largely interdependent. Thus, petroleum and textile fibers for certain Eastern European countries come from the U. S. S. R., west Germany imports much of its iron ore from Sweden, and France receives coking coal from the mines of Rhine westphalia. A similar interdepedence characterizes the heavy engineering industry. Steel sheets and billets, for example, are exported from one country to another where they are used for constructional engineering and the manufacture of automobiles.

France

France ranks second in industrialization in European countries after Great Britain. Britain, France and Germany are the major European industrial countries but most European countries have some important manufacturing activities as shown in Fig. 29·5.

The major industrial regions of France are as follows :

North East Industrial Regions

The continuation of the Belgian coal field into North France has made this region the largest industrial area of the country. It is devoted chiefly to the manufacture of textiles, engineering and iron and steel works. The woollen industry has been helped by the rearing of sheep on the chalk hills, though much foreign wool to supplement the some supply is now imported at Dunkirk and Havre. The chief towns for manufacturing wool are Roubaix, Reims and Amiens. The two last towns have noted cathedrals, but that at Reims was terribly damaged by the German bombardments. The linen industry has been aided by the cultivation of flax in the district around Lille and Cambrai, where it is carried on. Lille makes cotton, woollen, linen and synthetic textiles. Ronbaix has in fact, an important trade in wine, and the province of Champagne in which it stands has given its name to a noted kind of wine.

LORRAINE

The Lorraine since before World War I has contributed to the French economy some two-thirds of total steel and more than three-fourths of total pig-iron production. This region is, therefore, recognized as the single most important centre for such manufacturing.

The Lorraine iron and steel plants are grouped in three areas. Outstanding among these is the Metz-Thionville complex in the Mosselle valley. The mills there contribute about three-fifths of the Lorraine iron and steel output, and, in view of recent developments, chances for greater industrial expansion within this area have been enhaned considerably.

The second area is the Longway—Villerapt area near the Belgium Luxembourg border, often referred to as the Northern District. This area produces one-third of Lorraine's iron and steel.

Fig. 29 5. Industrial region


AN
HELSINKI
OSLO
OREBRO
STOCKHOLM
ESKILSTUNA
GOTEBORG
BANK
UGH
GDANSK
DAM
DORTMUND
ESSEN
BERLIN
MAGDEBURG
WARSAW
USSELS
DRESDEN
LEIPZIG
DUSSELDORF
WROCLAW
PRAGUE
KATOWICE
FRANKFURT
KRAKOW
MANNHEIM
PILZEN
STUTTGART
STRASBOURG
MUNICH
BASEL
BUDAPEST
TRIESTE
MILAN
TURIN
GENOA
VENICE
BELGRADE
SOFIA
ROME
NAPLES
STRIAL REGIONS
STRIAL CITIES
0
600 Km.

of Europe.

The third area is Nancy. Nancy has large iron and steel works.

GREATER PARIS

The capital of France has naturally arisen in the midst of this productive area, and at the best centre of the system of waterways formed by the Seine and its tributaries. Small sea—vessels can reach Paris, and the trade of its port is considerable ; but it is not a great manufacturing town, and suffers from lack of coal in the vicinity. Its chief manufactures are articles of fashion, as millinery, jewellery and gloves. The city is famous for its art or picture galleries. Important industries are automobiles, locomotives, aircraft and chemicals.

Besides these, they are many scattered industrial towns in France.

East and West Germany

German industrial development concentrations are characterized by a combination of several locational factors. Most of Germany's industries are concentrated in following regions :

THE RHINE RUHR REGION

The region is most important for its coal and iron ore mines and for the production of coke, steel chemicals, and heavy industries. This is the largest German industrial region. The importance of this region is due to its extensive, high-grade deposits of coking coal, its proximity to West German's only source of iron ore. The area is remarkable for its large concentration of cities. This industrial area contains more than 7 million people, nearly all of whom are dependent upon Ruhr industries. The Ruhr industrial region is dotted with iron and steel works, locomotive and chemical plants, and factories manufacturing equipment for mines and steel mills. Dinsburg is the leading Rhine port and the largest inland port of Europe.

THE CENTRAL GERMAN REGION

This extends eastward from the middle Weser River along the zone of the Southern Transitional Borderlands to the Elbe River, and south into the Central Uplands. Its various industries are largely based upon lignite and mineral salts. Lignite is the basic fuel for the production of electric power and for other energy uses. There are many industrial cities such as Hanover is more important for metallurgical and chemical industries ; Dessau for aircraft and engineering ; Salzgitter for steel works, automobile and textile plants ; Kassel for heavy machinery and locomotives ; Magdeburg for chemicals and engineering, Erfurt and Jena are famous for glass, optical instruments, bicycles, typewriter and Chinaware etc.

SOUTHERN SAXONY REGION

Lignite is still available and forms the basic source of power.

A large number of skilled workers are employed in the numerous textile plants and in the wood working and tanning industries which have grown up here. This region generally ranks second among German industrial districts, with textile predominating, and is wholly within East Germany.

Important cities are Plauen (Knitted goods, embroidery) Chemnitz (for textiles). Leipzig, a city of more than 700,000 people, which is one of Europe's oldest trading centres. Leipzig offers, among other things, raw materials for the chemical industry, chemical equipment and apparatus, machines processing plastics and elastomers, printing and textile machines, medical and laboratory equipment as well as motor vehicles.

THE MIDDLE RHINE INDUSTRIAL REGION

This industrial region extends along the Rhine from Mainz and Frankfurt-am-Main Southward to Karlsruhe. Frankfurt is a railway engineering centre with electrical, engineering, automobile and chemical industries. The twin cities of Mannheim-Ludwigshafen produce chemicals, electrical goods, iron and steel and agricultural implements. This region also produces precision instruments, tools and typewriter. This industrial region is situated in Western Germany.

Apart from the large industrial regions there are several large cities which have developed awide range of industries. In Neckar basin, the chief industrial city is Stuttgart, where cement works, textile plants, and precision instrument and other metal industries dot the whole landscape of Neekar basin.

The Saar situated along the German-French border is important centre or iron and steel industries. There are many rolling stock mills, repair shops and engineering industries.

East Europe

Polish iron and steel industry notes to its credit not only quantitative but also qualitative changes which testify to the constant technical and technological progress. In the steel industry, for example, the production of high quality steel varities, not manufactured so far, has been developed and the share of high quality steel in the overall output increased to 15·2 percent. However it is still too low compared with countries leading in that respect. The core of Polish manufacturing today is located in the 1500 km^2 coal-rich area of upper Silesia stretching between Katowice and the former German city of Oppeln or Opole. The iron and steel industries are by no means Poland's only industries of importance. Textile manufacturing has an old and important tradition, and Lodz is often called the Polish Manchester. The city is an important manufacturing centre for metallurgical, electrotechnical, chemical, food processing and other miscellaneous industries.

In Southern Europe *Milan, Turin* and *Genoa* triangle is important industrial region in Italy. Within this industrial region are located a wide variety of manufactures such as iron-steel, textiles,

chemicals, automobiles, machinery electrical good and agricultural implement. Genoa is noted for shipbuilding and repairing and engineering industries.

Industrial Regions of U.K.

The United Kingdom was the first country in the world to become highly industrialised, and today 14 people work in mining, manufacturing and building for every in agriculture. It is the worlds third largest exporter of manufactured goods, and the range of its industrial manufactures reflects its position as one of the most important workshops of the world. The major industrial regions are as follows.

THE MIDDLE REGION

The main industrial region of the Midlands consists of the great conurbation centred on Birmingham and Wolverhamptom (which includes portions of Stafforshire, Worcestershire and Warwickshire) where there is a wide variety of industry, including notably the manufacture of metals, electrical and engineering products of all kinds, and also jewellery, rubber products and domestic metalware.

Various cities specialize in the manufacture of different kinds of products —e.g. Bromsgrove (Worcestershire) in nails, and Redditch in needles and fish-hooks, while Wolverhampton and west Bromwich in Staffordshire, manufacture almost every conceivable kind of iron and steel article.

Birmingham is the largest trade centre of the district. It also manufactures steam engines and firearms, and is particularly noted for small metal goods and jewellery. Derby is important for engineering works and chemicals, and aero-engines.

Burton upon Trent is situated near the confluence of the Dove. It has become the largest beer and ale brewing centre in the countty, mainly on account of the suitable quality of the water here.

NORTH EAST ENGLAND

This is Britain's leading centre for heavy engineering and a wide range of metallurgical industries. The coal fields of Northumberland and Durham is associated with the iron industry and particularly with shipbuilding. The iron ore is brought from the rich iron mines of cleveland, in North Yorkshire, and the limestone, which facilitates the process of smelting is close at hand.

The chief towns engaged in shipbuilding are ports along the lower covers of the Tyne–New Castle, Jarrow, Gateshead, Wallsend and North and South Shields ; Sunderland on the wear, Middlesbrough on the Tees, and the Hartlepools, Tynemouth is a watering place but Darlington and Stockton in the valley of the Tees are engaged in the iron industry. Darlington specializes in locomotives. New Castle on the river Tyne has shipbuilding and transport equipment industries. Guns are made, and the manufacture

of glass and chemicals in the town has been stimulated by the salt found in the locality.

YORKSHIRE, NOTTINGHAMSHIRE AND DERBYSHIRE

Most of the Britain's industry is located in the west Riding where about 90 percent of the United Kingdom's worsted industry and the greater proportion of its woollen industry are found. Bradford is the commercial centre of the wool trade and important for worsted ; Morley and Leeds have specialised in cheaper cloths, and Batley, Dewsbury and Spenborough in heavy cloth, but their production is becoming more diversified. Huddersfield has a reputation for fine woollens and worsteds and Halifax for carpets. In most of the larger centres of the wool industry a variety of engineering products are manufactured.

Leeds, which stands on the Aire, at the base of the Pennines, is the centre of the woollen industry. It also manufactures boots and shoes and iron goods, including machinery. Various bronches of the woollen industry are also carried on at Huddersfield, Wakefield and Barnsley, and other towns. Farther south is the heavy engineering centre of Sheffield, famous for its high quality steels, cutlery and tools. The area's extensive coalfields provide about one-fifth of Britains coal. York noted for chocolates and confectionery manufacture and with important railway workshops and Hull, one of the world's largest fishing ports and with many manufacturing industries, including engineering, vegetable oil processing, paints and sawmilling, are other important industrial towns in Yorkshire.

THE LANCASHIRE REGION

This region is the commercial hub of the cotton and man-made fibre textiles industries, a vary important financial and commercial centre and a major port. This industry has become extremely important here, on account of many advantages which the district possesses for it, as well as the local supply of coal. The climate is extremely damp near the Penn nes, in front of which the westerly winds are obliged to rise, and this damp climate enables very fine threads to be spun and woven without beaking. Manchester is most important cotton textiles city of this region. Manchester has thus become a great centre for collecting and exporting the cotton goods made in the district round, and for distributing the raw cotton and food imported. Besides manufacturing cotton, silk and woollen goods, it makes a great deal of machinery, and since the opening of the Manchester Ship canal has become a large port.

The cotton-manufacturing towns of Bolton, Bury, Rochdale, Oldham and Stock port (in Chesshire), form a semi-circle round Manchester and lie mainly on the lower slopes of encircling north-east moorlands, where water power is availab'e. Oldham and Bolton are the chief spinning centres, while the most important cotton-weaving towns lie in the valley of the Ribble – *e. g.* Burnley,

Blackburn and Preston. Liverpool is the second port of Britain, a great commercial and insurance centre and, after London, the greatest centre for processing imported foodstuffs and raw materials, being noted especially for four milling, soap manufacture, sugar refining and rubber products. Liverpool is connected by a railway tunnel with the sea-port of Birkenhead, on the opposite side of the Mersey. Among its oldest industries is ship repairing, shipbuilding is a major industry across the river at Birkenhead Barrow in the north west of the country, is a well known shipbuilding and marine engineering area.

GREATER LONDON INDUSTRIAL REGION

London, situated at the head of ocean navigation on the Thames estuary, is Britain's capital and main communication centre the world's most important financial centre, one of the world's three targest cities after Tokyo and New York, and one of the world's three largest ports after New York and Rotterdam. The Thames did not long prove a barrier to the extension of the city, and on the south bank of the river, as well as in East London, various industries have sprung up to supply the needs of the dense population *i. e.*, sugar-refining, furniture, jam, soap, matches, candles etc. Specialized light engineering, though while disseminated, is increasingly concentrated in the London district, which is also the centre of the new "luxury" industries; London is surrounded by hundreds of new plants producing a thousand and one small products which reach the country's biggest market with case. The range of manufactures is wide, including cement, oil refineries, metal, chemicals and electrical industries as well as domestic industries.

CENTRAL SCOTLAND

Glasgow is the heart of Scottish industrial activity. Glasgow stands on the Clyde, at the lowest point at which it could be bridged in early days, and where it is now crossed by many bridges. It has, however, only risen to great importance since the steel ship building industry was established there, and since the clyde was deepened so that ocean vessels could reach the city. To its ship building it has added the manufacture of engines for steamers and trains, and other kinds of machinery. It has also potteries, chemical works, breweries and large factories for manufacturing cotton and woollen goods.

The second industrial town of this industrial region is Dundee. This is famous for jam industry. Dundee is also noted for the manufacture of carpets and sacking made of jute from India and Bangladesh, of ropes made of hemp chiefly from the Philippines, and of sackcloth and coarse linen made of flax which is mainly imported from Russia and Belgium. Dundee is therefore a very busy port, and has grown to be the third largest town in Scotland. Shipbuilding is carried on at the port.

BELFAST INDUSTRIAL REGION

Belfast stands at the mouth of the Lagan, where it flows into Belfast Lough. It has an excellent harbour, and communication by railway and canal with other towns. It has many large factories for manufacturing linen, for bleaching and dyeing goods, and for making mineral waters, besides flour mills, tobacco-mills and breweries. Shipbuilding is also a very important industry, but iron has to be imported from Scotland and Barrow to supplement the little found in Antrim. In connection with this industry other have been started for making engines, boilers, ropes, and sail cloth. There has also been extensive expansion in aircraft construction and in the manufacture of oil well eqiupment electronic instruments, telephone switchgear eqiupment etc.

INDUSTRIAL REGIONS OF NORTH AMERICA

The pattern of ownership and organization in industry is varied. Personal, corporate, cooperative and public enterprise all assune a number of different forms, and all are important in the economy. Industrial enterprise vary from the many small workshops to vast organization. The U. S. A. is now the wealthiest and most highly industrialized country of the world. A brief discription follows of the location of American industry, grouped according to broad geographical areas :

SOUTH NEW ENGLAND REGION

Boston is the main representative of this industrial region. Boston manufactures clothing and boots and refines sugar. It is the second port in the United States, exporting much of the grain and meat from the interior. Textiles and shipbuilding are tradinal industries of this industrial region. The cotton industry here benefits by the damp climate, and by the skill which workers have acquired through long practice. There are also large markets at hand for the goods, and every facility for distributing and exporting them. Water power is used in factories but coal is taking its place, and this has to be brought from farther South-West. Recently these states have felt the competition of cotton manufacturing towns in the south, where the cotton plantations are situated, as here the raw cotton has to be imported. The chief centres of the industry are Lowell, New Bedford, Worcester and Fall river. The engineering industry is still important at Spirngfield, Bridge port ann Hartford. In Beverly and Mass, the chief industries are manufacturing cotton goods, woollens, iron ware and boots and shoes, while Quincy specializes in shipbuilding. The South New England region is the greatest manufacturing region of North America. Practically every type of industry is represented in these citties.

Here manufacturing began early under the encouragement of numerous waterpower sites, a dense population supplying labour and markets, and rough stony lands that did nor encourage extensive agriculture. Although this region comprises only 50% of the

land areaof the United States and it had 27 precent of the population. This industrial region had more than 42 percent of the wage earners engaged in manufacturing in the country and it accounted for more than 70 percent of the net value of manufacturing. The table 29·1 shows the industrial structure of New England industrial region.

Table 29·1

Industrial Structure of New England Region*

Industry	Percentage of Labourers engaged in industrial purusuits	Percentage of nations industrial Production
Electrical machineries	10·7	13·2
Cotton Textiles	8·9	13 6
Machineries	8·3	8·5
Leather goods	7·7	30·0
Metal goods	6 8	8·9

THE MID ATLANTIC REGION

This region has a great diversity of manufactures. Indeed, the variety of product, from the wrist watch to the giant locomotive-

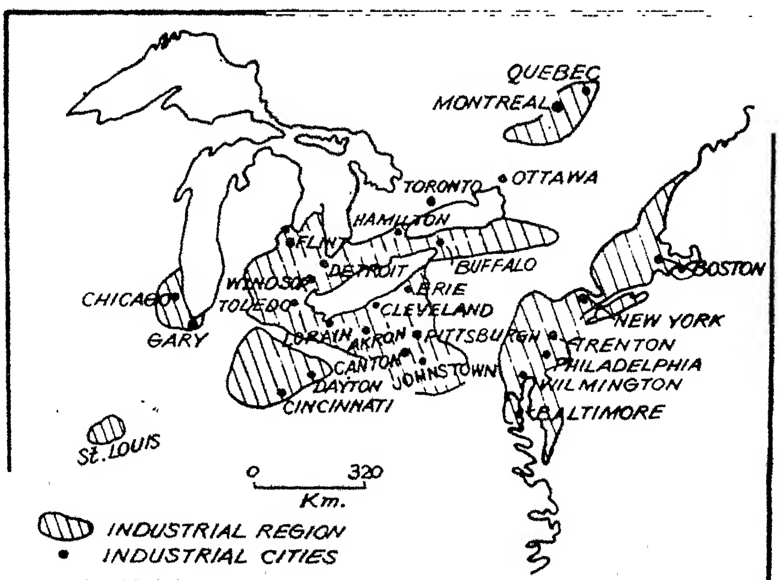


Fig. 29 6 Industrial regions of North East North America

* K. S. and J. S.—Arthik Bhugol Ka Mul Thatwa, p. 403.